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and FAA-E-2704A, 8/7/84

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

AIRPORT SURVEILLANCE RADAR (ASR-9)

1. SCOPE.- The equipment specified herein is an Airport Surveillance Radar (ASR) System capable of providing rho-theta information on aircraft targets within a 60 nautical mile radius centered upon the radar. This information is normally transmitted over telephone type communication lines for display to be utilized for control of air traffic. The system transmitters, receivers, processor channels, an antenna unit, weather channel, performance monitoring, and other required ancillary items. The transmitter site equipment shall be installed in an existing Federal Aviation Administration (FAA) ASR-4/5/6 building. Design features are included to permit interfaces with radar beacon and other associated equipment; and to provide performance, reliability, and maintainability characteristics consistent with the stringent requirements of air traffic control.

2. APPLICABLE DOCUMENTS.-

2.1 Federal Aviation Administration (FAA) Specifications.- The following FAA specifications of the issues specified in the invitation for bids or request for proposals form a part of this specification:

FAA-D-2494 Part 1	Instruction Book, Manuscripts, Technical, Equipment and System Requirements, Preparation of Manuscripts
FAA-D-2494 Part 2	Instruction Book, Manuscripts, Technical, Equipment and System Requirements, Preparation of Reproducible Copy
FAA-C-2256	Temperature and Humidity Control, Equipment

FAA-E-2319B	Air Traffic Control Beacon Interrogator and Amendments Thereto
FAA-E-2502	Air Traffic Control Radar Beacon System (ATCRBS) Test Set
FAA-C-1217	Electrical Work, Interior
FAA-E-2620	Radar Beacon Performance Monitor
FAA-E-2660	ATCRBS Open Array Antenna (5 foot)
FAA-G-2100/1	Electronic Equipment, General Requirements Part 1, Basic Requirements for All Equipments
FAA-G-2100/3	Part 3, Requirements for Equipments Employing Semiconductor Devices
FAA-G-2100/4	Part 4, Requirements for Equipments Employing Printed Wiring Techniques
FAA-G-2100/5	Part 5, Requirements for Equipments Employing Microelectronic Devices
FAA-G-1210	Provisioning Technical Documentation
FAA-G-1375	Spare Parts - Peculiar for Electronic, Electronic, Electrical and Mechanical Equipment

2.2 Military standards.- The following military standards of the issues in effect on date of invitation for bids or request for proposals form a part of this specification and are applicable to the extent specified herein unless a specific version is indicated below:

MIL-STD-785	Requirements for Reliability Program (For Systems and Equipments)
MIL-STD-461	Electromagnetic Interference Test Characteristics Requirements for Equipment
MIL-STD-470	Maintainability Program Requirements (For Systems and Equipments)
MIL-STD-756B	Reliability Prediction
MIL-STD-781B	Reliability Tests, Exponential Distribution
MIL-STD-471A	Maintainability Verification Demonstration and Evaluation
MIL-STD-462	Electromagnetic Interference, Characteristics, Measurement of

MIL-STD-965	Parts Control Program
MIL-STD-1130	Connections, Electrical Solderless Wrapped
MIL-STD-1313	Micro-electronic Terms and Definitions
MIL-STD-454	Standard General Requirements for Electrical Equipment

2.3 Military specifications.- The following military specifications of the issues in effect on the date of the invitation for bids or request for proposals form a part of this specification and are applicable to the extent specified herein.

MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment
MIL-HDBK-472	Maintainability of Predictions
MIL-C-5541	Chemical Films and Chemical Film Materials for Aluminum and Aluminum Alloys
MIL-C-6021	Clarification and Inspection of Coating
MIL-C-8514	Coating Compound, Metal Pretreatment Resin Acid
MIL-C-15305	Coil, Radio Frequency, and Transformer, Intermediate and Radio Frequency, General Specification
MIL-C-39010	Established Reliability General Specifications Coil, Fixed Radio Frequency (Molded)
MIL-C-83286	Coating, Urethane Aliphatic, Isocyante Aerospace Applications
MIL-F-15733	Filter Radio Interference, General Specification for
MIL-M-38510	General Specification for Micro-Circuits
MIL-P-23377	Primer Coating Epoxy Polyamide Chemical and Solvent Resistant
MIL-T-27	Transformers and Inductors (Audio, Power, and High Power Pulse) General Specification for
MIL-T-21038	Transformers, Pulse, Low Power, General Specification for

2.4 Federal Aviation Administration (FAA) Drawings.- The following FAA drawings form a part of this specification to the extent specified herein.

D-5419-1 through 8, and 14, Airport Surveillance Radar, ASR-4 through ASR-8 Tower, Design and Installation Details

D-5417-1 through 9, ASR-4 Building

D-5648-1 through 10, ASR-5 Building

D-6048-1 through 10, ASR-4, 5, 6, Prefabricated Building

D-6075-153 Lightning Protection for ASR Towers

D-5454-1 through 18 Airport Surveillance Radar, ASR-4 through ASR-7 Tower Fabrication

D-5453-E1 through E16 Airport Surveillance Radar, ASR-4 through ASR-7 Tower Erection

2.5 Naval Research Laboratory (NRL) Report.- The following NRL report forms a part of this specification and is applicable to the extent specified herein.

NRL Report 6930, "A Guide to Basic Pulse-Radar Maximum - Range Calculation," dated December 23, 1969.

2.6 Federal Aviation Administration (FAA) Standards.- The following FAA standards of the issue specified in the invitation for bids or request for proposals form a part of this specification:

FAA-STD-002	Engineering Drawings
FAA-STD-010	Graphic Symbols for Digital Logic Equipment
FAA-STD-016	Quality Control System Requirements
FAA-STD-018	Computer Software Quality Program Requirements
FAA-STD-019	Lightning Grounding, Protection Bonding, and Shielding Requirements for Facilities
FAA-STD-020	Transient Protection Grounding, Bonding and Shielding Requirements for Equipment
FAA-STD-021	Configuration Management

2.7 Federal Documents.- The following Government publications of the issues in effect on the date of the invitation for bids or request for proposals form a part of this specification and are applicable to the extent specified herein.

FED-STD-595: Color

Federal Supply Code for Manufacturers: GSA-FSS.H4-1 through H4-2, August 1979

FED-STD-1031 Telecommunications: General Purpose 37-Position and 9-Position Interface between Data Terminal Equipment and Data Circuit Terminating Equipment

FED-STD-1007 Telecommunication, Coding, and Modulation Requirements for Duplex 9600 Bit/Second Modems

Federal Item Name Directory for Supply Cataloging of GSA-FSS.H6

2.8 Rome Air Development Center (RADC) Documents.- The following RADC documents of the issues in effect on the date of the invitation for bids or request for proposals form a part of this and are applicable to the extent specified herein:

RADC-TR-64-377	Study of Part Failure Modes
RADC-TR-75-22	Non-Electronic Reliability Handbook
RADC-RDH-376	Reliability Design Handbook

2.9 Federal Aviation Administration (FAA) Orders.- The following FAA orders form a part of this specification and are applicable to the extent specified herein:

FAA-Order-1010.51A	U.S. National Standard for the IFF Mark X (SIF) Air Traffic Control Radar Beacon System (ATCRBS) Characteristics
FAA-Order-6365.1A	U.S. National Aviation Standard for the Mode Selection Beacon System (Mode S)
FAA-Order-6970.1B	Temperature and Humidity Control of FAA Facilities
FAA-Order-6950.19	Practice and Procedures f Lightning Protection, Grounding, Bounding and Shielding Implementation

2.10 Lightning Protection Code.- NFPA78, ANSI C5.1

2.11 Other documents.- The following publications of the issues in effect on the date of the invitation for bids or request for proposals form a part of this specification and are applicable to the extent specified herein:

NAS-MD-790	Interface Control Document for the Remote Maintenance Monitoring System (ICD-1) Maintenance Processor Subsystem (MPS)/Remote Maintenance Subsystem (RMS). This document is hereinafter referred to as ICD-1 or ICD Level 1

EIA-STD-RS-422 April 1975, Electrical Characteristics of Balanced Voltage Digital Interface Circuits (FED-STD-1020)

EIA-STD-RS-449 General Purpose, 37 Position, and 9 Position Interface for Data Terminal Equipment and Data

FAA Order 1830.2 Policy for use of Telecommunications Data Transfer Standards

FAA Report RD-76-190 Section V Paragraph F (3/8/77) Subclutter Visibility Measurements with the Test Target Generator

National Electric Code

ANSI-Y1.1 (1972): Abbreviations for Use on Drawings and Text

ASTM-B224: Copper and Classifications

IEEE-488: Digital Interface for Programmable Instrumentation and Related Systems Components Standards

Manual of Regulations and Procedures for Federal Radio Frequency Management: Issued by National Telecommunications and Information Administration

Copies of this specification and other applicable FAA specifications, standards, and drawings may be obtained from the Contracting Officer in the FAA office issuing the invitation for bids or request for proposals. Requests should fully identify material desired; i.e., specification, standard, drawing numbers, and dates. Requests should cite the invitation for bids, request for proposals, the contract involved, or other use to be made of the requested material. Information on obtaining copies of Federal specifications and standards may be obtained from General Services Administration offices in Atlanta; Auburn, Washington; Boston; Chicago; Denver; Fort Worth; Kansas City, Missouri; Los Angeles; New York; and Washington, D.C.

Requests for copies of military specifications and standards should be addressed to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

Copies of the NRL report may be obtained from the National Technical Information Service, Springfield, Virginia 22151.

3. REQUIREMENTS.-

3.1 Summary of equipment to be furnished by contractor.- The contractor shall furnish the quantity of ASR-9 subsystems specified in the contract. Any item or part necessary for proper operation and adjustment in accordance with the requirements of this specification shall be incorporated even though that item or part may not be specifically provided for or described herein. All features required to meet performance requirements, such as shock mounting of particular modules or assemblies, heat circulation by means of blowers, controls, indicator lamps, overload protection devices, meters, test points, interlocks, switches, etc., shall be incorporated even though the features may not be specifically provided for, or described herein. All facilities, parts, and hardware, including receptacles, connectors, cabling (wiring), adapters and outlets shall be incorporated to enable the components of the system to be properly assembled, interconnected, installed, and maintained as required herein. Each system shall be complete, in accordance with all specification requirements, and shall include the following major items, unless modified by the contract schedule. (All other items not listed below, but required for system operation, testing, or adjustment in accordance with the requirements of this specification shall also be furnished.):

(a)	1 each	Performance monitor and control system, paragraph 3.13 and subparagraphs
(b)	1 each	Antenna assembly, paragraph 3.8 and subparagraphs
(c)	1 set	Azimuth position data equipment, paragraph 3.8.8 and subparagraphs
(d)	1 lot	Waveguide, paragraph 3.14.7 and subparagraphs
(e)	1 each	Waveguide switches, paragraph 3.14.5
(f)	1 each	Radio Frequency (RF) dummy load, paragraph 3.14.6
(g)	2 each	Transmitter/modulator assembly, paragraph 3.10 and subparagraphs
(h)	2 each	Receiver assembly, paragraph 3.11 and subparagraphs
(i)	2 each	Moving Target Detector (MTD) processing subsystem, paragraph 3.12 and subparagraphs
(j)	1 lot	Ducts, cabling, hardware, etc.
(k)	1 set	Junction box panels and junction boxes, paragraph 3.17
(l)	1 each	Maintenance Planned Position Indicator (PPI), paragraph 3.18.11 and subparagraphs
(m)	1 set	Special Maintenance Equipment, paragraph 3.2.15
(n)	1 set	Intercommunications system, paragraph 3.18.12

(o)		Not used
(p)	3 each	Surveillance and communications interface processor, paragraph 3.12.7
(q)		Unused
(r)	17 each - 700 9 each - 400	Display video control box, paragraph 3.12.7.12, 17 each at 700 Aircraft capacity sites and 9 each at 400 aircraft capacity sites
(s)	4 each	Radar system control panels, paragraph 3.16.7
(t)		Unused
(u)	1 set	Modems, paragraph 3.4.1.1
(v)	1 each	Weather receiver, paragraph 3.21 and subparagraphs

3.2 Definitions.-

3.2.1 Principal azimuth plane.- The principal azimuth plane is a plane which includes: (1) the line of maximum radiation from the antenna; and (2) an intersecting horizontal line which is normal to the line of maximum radiation. This definition assumes the antenna to be in the normal operating position.

3.2.2 Principal elevation plane.- The principal elevation plane is a vertical plane passing through the center of the reflector and including the line of maximum radiation from the antenna in its normal operating position.

3.2.3 Local and remote.- The words "local" and "remote" used herein refer to the transmitter/receiver site and air traffic control/indicator sites, respectively.

3.2.4 Preheat.- In this specification, preheat refers to those circuits and functions which must be energized, sequenced, and stabilized before the transmitter HV may be applied.

3.2.5 Radiating and standby channels.- The radiating or active channel is defined as the channel connected to the antenna. The standby channel is the channel connected to the RF dummy load.

3.2.6 Nose of the beam.- The nose of the beam of the antenna is defined as the intersection of the principal azimuth plane with the principal elevation plane.

3.2.7 System Mean-Time-to-Restore (MTR).- The mean time to restore the ASR-9 System to an operational condition. It is equal to the total corrective maintenance time to restore the ASR-9 to an operational status, divided by the total number of corrective actions during a given period of time.

3.2.8 Availability.- The probability of specified operability at any instant in time over the service life of the equipment. Allowed preventive maintenance times shall not be counted as unavailable periods provided the requirement to reach an operable state is always met.

3.2.9 Subsystem Mean-Time-to-Repair (MTTR).- The total corrective maintenance time divided by the total number of corrective maintenance actions during a given period of time.

3.2.10 Service life.- The ASR-9 shall have a useful life of 20 years. Any nonconsumable configuration items and components produced for the ASR shall be designed to function properly for a 20-year period under mission operating conditions of 24 hours per day, 7 days per week with downtime for corrective and preventive maintenance as defined for reliability, maintainability, and availability in this specification.

3.2.11 Failure categorization.- All malfunctions shall be categorized as either a relevant failure or a nonrelevant failure.

3.2.11.1 Relevant failure.- Any failure occurring or detected during test time which results in failure to comply with specified performance parameters and which is not specifically defined as nonrelevant shall be categorized as relevant failure.

3.2.11.2 Externally induced.- All externally induced failures shall be classified nonrelevant. Externally induced failures are those that result from factors external to the ASR-9 equipment. They include failures attributable to test equipment, test facility, and errors by operating and maintenance personnel. Commercial power system failure is an example of an externally induced failure.

3.2.11.3 Failures outside of test time.- All failures that occur when "test time" has been stopped shall be classified nonrelevant.

3.2.11.4 Secondary failures.- If one part is responsible for the failure of any other part, each secondary part failure shall not be counted as a relevant equipment failure.

3.2.11.5 Nonrelevant function failures.- Failures of functions not essential to the performance capabilities of the radar single channel (paragraph 3.2.12) are not relevant; specifically, failure of elapsed time meters, individual illumination lamps, voltage and current meters, except where those failures cause secondary failures in the essential performance capabilities of the radar system.

3.2.11.6 Corrected failures.- Failures attributable to deficiencies for which corrective action is taken and is shown to be effective in eliminating the failure mode shall be classified nonrelevant. Further, it must be shown and/or demonstrated that no new failure modes are introduced by the corrective action.

3.2.11.7 Redundant elements.- Failures of redundant elements, the functions of which may be performed by back-up elements while maintaining specified performance of both radar channels, shall be considered nonrelevant; e.g., Pulse Modules in Transmitter Modulator, System Control Panels except "single thread" functions such as the "transfer of system control" circuitry.

3.2.12 Airport Surveillance Radar (ASR-9) single channel.- A single channel when interconnected in an operational mode includes the following equipment: (1) all hardware from the channel side of the waveguide switch to the receiver and transmitter; (2) transmitter; (3) receiver; (4) 6 level Wx channel in parallel with 2 level Wx from Correlation and Interpolation (C&I); (5) digital signal processor; (6) correlation and interpolation processor; (7) surveillance processo ; (8) modems; (9) dual sensor communications interface processor; (10) system control box; (11) video distribution subsystem; (12) the Azimuth Change Pulse (ACP)/Azimuth Reference Pulse (ARP) channel and distribution systems supporting the above equipment; and (13) Remote Maintenance Subsystem (RMS).

3.2.13 Mean bench repair time.- It is equal to the total corrective bench repair time required to restore any line replaceable unit or module to operational status divided by the total number of failed units during a given period of time.

3.2.14 Standard maintenance equipment.- Standard maintenance equipment is defined as tools and test equipment carried as a standard line by the contractor or another manufacturer, this supersedes FAA-G-2100/1, paragraph 1-3.16.23.

3.2.15 Special maintenance equipment.- Special maintenance equipment is defined as tools and test equipment not carried as a standard line by the contractor or another manufacturer. Special tools are defined as tools, jigs, alignment fixtures, etc., required (for example, for maintenance of the antenna). Special tools and test equipment shall be furnished by the ASR contractor.

3.3 Power source.- The equipment shall normally operate from a commercial prime power source of three phase, four wire Alternating Current (AC), Line. The design center voltages shall be 60Hz, 208V Phase-to-Phase and 120V Phase-to-Neutral with a maximum voltage range allowance $\pm$ 15 percent. In case of failure of the prime power source, power from an auxiliary engine generator source (not a part of this specification) will be automatically connected to furnish power to the equipment within 15 seconds. Prior to prime power switchover, the remnants of commercial power (e.g., loss of one phase) normally remain connected to the radar system.

3.3.1 Prevention of data loss.- The contractor shall provide the means for maintaining any critical data necessary to restore normal operation immediately upon restoration of power when primary power failure occurs for 15 seconds or less. This restoration shall be automatic except that the HV will have to be reset manually. Data to be retained, as a minimum, shall include digital signal processor clutter map levels, digital signal processor parameters, geosensor map, C&I adaptive threshold maps, tracking data base, weather map, and beacon target detector parameters.

For momentary power interruptions or AC line undervoltage transients, the following modifies paragraph 1-3.3.5 of FAA-G-2100/1B. The transmitter is not required to radiate during this interval of undervoltage; however, upon reapplication of line voltage the transmitter will resume full normal operation. Additionally, the radar system will resume normal operation without loss of critical radar timing such as APG and RAG data.

If a battery system is provided for the prevention of data loss, it shall be charged automatically when AC power is available to operate the radar. For power interruptions in excess of 15 seconds, restoration shall be automatic except that HV will have to be reset manually. The system restoration time shall only be limited by the transmitter preheat time afte AC power is restored.

3.3.2 Service conditions.- The service conditions shall be those given in 1-3.2.23 of FAA-G-2100/1. Ambient conditions shall be as follows: Environment II, except antenna assembly and associated equipment which shall be Environment III. The equipment shall function properly across the entire temperature range without being allowed to stabilize at any point within that range.

3.4 System performance and basic design.- In addition to meeting all individual subsystem requirements specified herein, the complete system shall perform and be designed and fabricated in accordance with the following subparagraphs.

3.4.1 System description.- The radar specified in this document is a highly reliable, ASR operating in the 2.7 to 2.9 GHz band and shall provide rho-theta positional information for aircraft targets within 60 nm radius of the radar location under conditions of ground clutter, weather, angel clutter, interference, and ground vehicular traffic. Except for the weather receiver, antenna and ancillary monitoring and control subsystems, the equipments in the

One channel of the dual system shall be active (radiating) while the other, the standby channel, shall be able to assume active channel status upon activation of a manual switch. The antenna in the ASR-9 shall include dual feed horns, one for a low beam capable of radiating and receiving and the second for a receive only high beam. Both shall be capable of handling circular and linear polarized signals. In order to increase the antenna reliability, dual drive trains, either one capable of driving the antenna independently of the other, are specified. The ASR-9 transmitters shall generate coherent RF pulses from a klystron amplifier. The drive to the klystron shall be derived from a crystal controlled source. The transmitter shall be modulated by pulses at two Pulse Repetition Frequencies (PRF), switching PRF's at the end of each Coherent Processing Interval (CPI). Receivers shall be low noise, with high dynamic range and good linearity, sufficient to provide the dynamic range required by the MTD processors. The output of the receiver's Intermediate Frequency (IF) amplifiers shall drive linear quadrature phase detectors (I&Q). The output of the phase detectors shall be amplified if required, and shall be quantized by high speed twelve (12) bit Analog to Digital (A/D) converters. The digital output of the A/D converters shall be interfaced with the Digital Signal Processor (DSP) or to the maintenance Single Gate Processor (SGP). The DSP shall process the returns for each range cell and perform coherent integration of the doppler spectrum for each CPI. The Doppler Filter Response (DFR) for each of the filter outputs shall be thresholded independently by means of adaptive thresholds. Responses that exceed the adaptive thresholds are primitive range doppler outputs for the CPI. The centroid for each cluster of these primitive responses shall be computed into target reports in the Correlation and Interpolation (C&I) processor. Additional thresholds shall be provided to reduce the effects of angel clutter, weather and ground vehicular traffic. The Surveillance Processor (SP) will provide additional processing for the ASR-9 data or Mode S system data. The SP when processing ASR-9 data shall also accept the raw beacon video from the collocated ATCBIS receiver and shall perform the necessary signal processing to convert the received pulse trains to digital messages suitable for transmission to the remote site. Target reports from the Correlation and Interpolation (C&I) processor shall be compared to the beacon reports and if the reports are at the same range and azimuth, a reinforced bit shall be set in the beacon message. C&I targets that merge with beacon messages shall not be disseminated to the remote facilities but shall be immediately placed in a higher activity state in the report to track correlation function. By means of a simple tracker algorithm, the SP shall determine the course and speed of all C&I targets and predict the position for the targets for the next scan. The SP, in the event of Mode S processing failure, shall accept and process raw beacon video from the Mode S system or when Mode S is on line, the SP shall accept and process Mode S beacon target reports, Mode S beacon and radar merged reports, and radar reports from C&I which have not merged with Mode S beacon reports. The output of the SP shall be transmitted to the remote site via modems over telephone or No. 19 AWG shielded twisted pair lines for further processing in the Surveillance and Communication Interface Processor (SCIP). The SCIP shall have as inputs, the digital MTD, beacon data and weather contours. The SCIP shall delay the beacon video for a time equal to the radar processing delay in the MTD and shall generate ACPs and ARPs at the proper time, based on synch pulses received from the SP. The SCIP shall generate an analog video signal for each target message at the proper rho-theta position of the target, at the time the PPI sweeps by that position. The output of the SCIP shall be compatible with and shall interface with PPI displays; Type FA-8320 (ARTS-III), Type FA-9030 (ARTS-II), TPX-42, and BRITE. The SCIP shall also provide the interface between the surveillance site and the ARTS. This interface includes not only the SP modem output from the radar site, but will also be capable of handling like outputs from the future Mode S sensors as well as the digital communication links between ARTS and Mode S. In addition, the ASR-9 shall include ancillary equipment for control and readback functions and for monitoring the performance of the system. A maintenance display driven by a maintenance display processor at the radar site shall be provided.

<u>3.4.1.1 System interfaces</u>.- All data transmission interfaces with the local ASR site shall be by means of contractor furnished modems via Government Furnished Equipment (GFE) land lines. The modems shall be interconnected by shielded twisted pair and/or telephone lines, up to 50,000 feet remoting can be over #19 shielded twisted pair. Over 50,000 feet, a combination of #19 shielded twisted pair and telephone lines can be utilized. All modems supplied by the contractor shall be long haul 9,600 bits per second modems conforming to FED-STD-1007. The contractor shall provide all modems and/or any subsystems required to transmit data over 3002 type leased unconditioned lines and/or #19 shielded twisted pair equivalent in both the half-duplex and full-duplex modes of transmissions. The modem system supplied by the contractor shall be able to automatically detect transmission line and modem failures at the local or remote site. The modem system shall also provide automatic fault correction by switching to a spare transmission line or modem at the local or remote site. The automatic fault detection and correction system shall provide real time transmission line and modem performance measurements and complete and continuous modem/terminal interface monitoring without interruption of data transmission. Automatic fault detection and switching shall not increase the number of transmission lines required except for spares. In the event of data channel failure, a switching matrix shall be provided to switch in either a spare data channel or the spare subsystem to replace the failed subsystem of the data channel. The switching matrix shall accommodate at least six data channels. Data channel shall be defined to include any physical equipment such as the transmission line, the local and remote modem required for automatic transmission, and reception of data. Automatic fault detection shall be provided for each modem. The automatic fault detection and correction systems shall monitor at a minimum receive signal level, signal to noise ratio, phase jitter, status, and RS449 interface. The error rate of modem shall not exceed $1x10^{-6}$ under simulated channel signal to noise ratio test conditions greater than or equal to 24dB. The modem shall include the following diagnostic offline testing:

(a) Local and remote digital loopback to return the output of the transmitting device to its input via the local modem interface and the remote modem, respectively.

(b) Local and remote analog loopback to return the output of the transmitting device to its input via the local modem itself and the opposite end off the communications line, respectively.

(c) Self-test to simulate actual operation of the modem and diagnostic transmission problems that influence the quality of the transmitted signal.

As a minimum, the modems shall provide the following visual status indicators:

(a) Carrier detect - To indicate receipt of a signal.

(b) Signal quality - To indicate the probability of a good, marginal, or poor error rate.

(c) Test mode - To indicate that the modem is in a test mode.

(d) Loopback test - To indicate the results of loopback tests.

(e) Modem check - To indicate errors detected during self-test.

The contractor shall provide a modem system alarm to the ASR-9 RMS in the event of a failure. One spare modem shall be provided by the contractor for each type of modem in use. The add-on capability shall be provided such that, if a second set of modems is added, completely dual data paths would be available between the radar site and the dual SCIP's. The contractor shall provide dual, redundant isolated outputs of all data to allow remoting of the data to two separate locations. At locations specified in the contract, where the dual remoting shall be required, the contractor shall provide all required additional modems. These locations shall be listed in the IFB. All data transmission between the local and remote sites shall be in accordance with appendix III.

3.4.2 System coverage.- The contractor shall prove the required maximum coverage by means of calculations. These calculations shall be furnished prior to the acceptance of the first system. Calculations, utilizing measured system parameters except for the constants provided herein, shall be performed in accordance with NRL Report 6930, "A Guide to Basic Pulse - Radar Maximum - Range Calculation," dated 23 December 1969. Such calculations shall indicate detection of a target of one square meter radar cross section with a probability of detection of 0.8 at a range of 55 nautical miles inbound and outbound. The target is assumed to be at the nose of the low-beam radiation pattern; the radar is assumed to be operating in linear polarization with the antenna mounted atop a 47 foot tower. Swerling Case 1 target fluctuation and 10^{-6} false alarm probability shall be assumed. NRL format for the calculations shall be the work sheet on page 94 of the report. Supporting calculations and individual measured parameters shall be included.

3.4.3 System performance characteristics.- The following parameters summarize the characteristics of the system; improvements in certain areas may be required due to system losses, etc., in order to provide the coverage of paragraph 3.4.2. These characteristics apply for single channel operation, and throughout the frequency range of 2700 to 2900 MHz.

Transmitter	
Transmitter peak power (measured at power coupler)	1.32 MW (maximum)
Pulse width	1.05 us (maximum)
PRF	1200 Hz (maximum)
Radiated frequency	2700-2900 MHz
Noise Figure (measured at receiver side of circulator)	4.1 dB (maximum)
Sensitivity	-108 dbm (minimum)

Antenna	Main (low) Beam	Passive (high) Beam
Power Gain, relative to isotropic source	33.5 dB (min.)	32.5 dB (min.)
Azimuth Beamwidth, principal azimuth plane, -3 dB	1.3 degrees (min.)	1.3 degrees (min.)
Elevation Beamwidth, -3 dB	4.8 degrees (min.)	4.8 degrees (min.)
Polarization - Selectable, linear/circular		
Rotation Rate - 12.5 RPM		
Overall VSWR - 1.4:1 maximum (Measured at input to rotary joint, all S-Band paths)		

3.4.3.1 System stability.- The radar system shall use highly stable frequency sources to insure that the total system instability residue prior to coherent filtering shall be equal to or less than -60 dB referred to peak signal (+63 dB Signal to Noise Ratio (S/N)) at all ranges to 60 nm, measured as outlined in paragraphs 3.13.5 and 3.13.6.

3.4.3.2 Capacity.- The ASR-9 System shall be capable of processing weather and a total of 400 or 700 aircraft targets plus 300 nonaircraft primary targets distributed uniformly or nonuniformly in azimuth. The selected weather channel (two-level or six-level weather channel) shall provide updated weather information on the ATC display within the interval of nine scans or less and be available for display as follows: Collection and processing of all weather data shall be completed every six scans or less at the radar site and completely transferred (all 30,720 cells) into the SCIP within three scans or less of completion of collection and processing of weather data. Each weather resolution cell is a nominal 1/2n mile by 1.4 degrees (approximately 30,720 weather cells). The beacon detector system shall be capable of handling 450 or 800 target reports that are distributed uniformly or nonuniformly in azimuth. This shall include limiting cases of nonuniform distribution as follows prior to the surveillance processor for any mix of beacon, primary or clutter targets:

(a) A peak of 250 total targets uniformly distributed across 8 contiguous 11.25 degrees sectors, (90 degrees of antenna scan).

The peak distribution of primary targets to be processed by the DSP and C&I shall consist of 11,000 primitives (threshold crossings).

(b) A peak of 100 total targets uniformly distributed across two contiguous 11.25 degrees sectors.

(c) A short-term peak of 16 targets in a 1.3 degree azimuth wedge, for not more than two contiguous wedges.

This short-term peak distribution of primary targets/clutter to be processed by the DSP and C&I shall consist of 1,200 primitives (threshold crossings).

(d) Target overload conditions shall be handled in an orderly manner; e.g., reduced processing range.

(e) The requirement for 700 aircraft capacity system are as follows: The DSP and C&I shall be able to process 31,000 primitives (threshold crossings).

(f) The requirement for beacon target reports shall be based on 400 valid aircraft with 50 additional garbled reports or 700 valid aircraft with 100 additional garbled reports.

The design shall be capable of being altered simply (by the addition or removal of hardware and software modules) in order to process 700 aircraft. The Government will identify requirements for 700 capacity systems in the contract schedule.

3.4.3.3 Primary radar accuracy.- The range and azimuth accuracy for the primary radar system shall be as follows.

3.4.3.3.1 Range accuracy.- For an aircraft target with median S/N greater than 30 dB, the range errors shall not exceed ±1/32 nm bias and 200 feet RMS jitter where the effective surface velocity of light is 299,710,000 meters per second or approximately 12.3586 microseconds per radar nautical mile.

3.4.3.3.2 Azimuth accuracy.- For an aircraft target with median S/N greater than +30 dB and at an elevation angle of 1 degree to 20 degrees with respect to the radar antenna horizontal plane, the system shall achieve an azimuth accuracy of 0.16 degrees, RMS. For elevation angles greater than 20 degrees with respect to the horizontal plane of the radar antenna, the RMS error in degrees shall not exceed 0.15/(cos elevation angle).

3.4.3.4 Beacon Target Detector (BTD) performance requirements.- The ASR-9's BTD shall meet the following requirements for beacon target returns consisting of replies with the specified round reliability from a transponder with capabilities in Modes 2, 3A and C which is in the presence of the maximum fruit density permitted by paragrap 3.4.3.4.8. A mode interlace 2, 3A and C shall be used and the BTD shall be configured to use Modes 2 and 3 and Mode C replies in the target detection process. Antenna and scanning modulation effects shall not be considered in these requirements.

3.4.3.4.1 Probability of detection.- The minimum probabilities of detection (P_d) on targets having round reliabilities of 0.5 and 0.75 are shown in the following tables:

DETECTION REQUIREMENTS

ROUND RELIABILITY = 0.5

TOTAL	MODES RESPONDING		
INTERROGATIONS	ALL	HALF	THREE FOURTHS
8	.640	--	.360
12	.900	.340	.700
16	.950	.460	.810
20	.980	.550	.890

ROUND RELIABILITY = 0.75

TOTAL	MODES RESPONDING		
INTERROGATIONS	ALL	HALF	THREE FOURTHS
8	.970	.320	.830
12	.998	.810	.970
16	> .999	.890	.990
20	> .999	.940	.995

3.4.3.4.2 Range resolution.- The range resolution capability of the beacon target detector, as discussed below, shall be achieved with the transponder operating with characteristics outlined in FAA Order 1010.51A as follows:

(1) The total jitter of the reply pulse code group, with respect to P3, shall not exceed ± 0.1 microsecond for receiver input levels between 3 and 50 dB above minimum triggering level.

(2) Delay variations between modes on which the transponder is capable of replying shall not exceed 0.2 microseconds.

The transponder time delay, defined as the delay between the arrival at the transponder of the leading edge of P3 and the transmission of the leading edge of the first pulse of the reply, shall be considered the same for the two targets discussed in the range resolution requirements below. At least 95 percent of the time, the BTD shall resolve two detected, stationary and identical, noninterfering targets with the same center azimuth if they are separated (in slant range) by 0.05 to 0.5 nmi inclusive. The targets shall be resolved at least 99.9 percent of the time when they are separated by more than 0.5 nmi. Any two detected targets which have an average range separation of 5 nmi or less, have the same center azimuth, do not mutually interfere having differing codes (including Special Position Identifier (SPI) and X pulses), and have any relative radial velocity which is consistent with the mutual noninterference requirement, shall be resolved at least 99.5 percent of the time.

3.4.3.4.3 Azimuth resolution.- At least 95 percent of the time, the BTD shall resolve two detected, stationary, and identical targets which are within 0.05 nmi of each other in slant range and which are separated by an absence of beacon replies (with decoded ranges which are within that 0.05 nmi interval) for 18 radar sweeps or the number of replies in each target, whichever is greater. Two detected noninterfering, stationary or moving targets which are within 0.05 nmi of each other in slant range and have at least one distinguishing characteristic shall be resolved at least 99.5 percent of the time. This requirement shall apply up to and including the condition of contiguousness (adjacent in azimuth with no intervening sweeps.) Distinguishing characteristics shall include different Mode 2 or 3/A codes (including SPI and X pulses), differing Mode C altitudes, a military emergency code train, or nonresponse of one aircraft to an interrogation mode to which the second aircraft responds.

3.4.3.4.4 Range Accuracy.- The BTD shall report all detected targets at their correct slant range with the least significant bit of range report equalling 1/64 nm. The standard deviation of the range error shall be less than 1/32 nm.

3.4.3.4.5 Azimuth accuracy.- The BTD shall report all detected targets at their correct azimuth with the least significant bit of the azimuth report equalling 1 ACP (0.088 degrees). The standard deviation of the azimuth error for targets with from 8 to 20 total interrogations shall be no greater than the values shown in the following table:

DETECTION REQUIREMENTS

STANDARD DEVIATION OF AZIMUTH ERROR (ACP's)

ROUND	MODES RESPONDING		
RELIABILITY	ALL	HALF	THREE FOURTHS
0.5	4.0	6.0	5.0
0.75	3.0	4.0	3.0

3.4.3.4.6 Split reports.- The BTD shall not generate more than one beacon target report from a single aircraft's beacon reply sequence which is in response to interrogations from the associated beacon radar, providing that it has a discrete Mode 2 or 3/A code. For aircraft without the discrete Mode 2 or 3/A capability, no more than 1.0 percent of their reports shall be split reports.

3.4.3.4.7 Code validation and accuracy.- The BTD shall validate the beacon code information as contained in the aircraft's reply for Modes 2, 3/A and C (including SPI and X pulses) at least 95 percent of the time when the number of actual hits received per mode is five or greater. When the actual number of hits per mode is 11 or more, the codes shall be validated at least 98 percent of the time. Validation of incorrect codes (due to fruit or other causes) shall occur less than 1.0 percent of the time. The validated codes shall be accurate at least 99 times out of 100.

3.4.3.4.8 False reports.- The BTD shall produce no more than one false target report per scan. This is an overall requirement and shall be met in the steady-state fruit condition of 10,000 fruit replies per second, with any or all target conditions permitted herein, other than a mix of aircraft in which the number of nondiscrete Mode 2 or 3/A aircraft exceeds 30 percent of the total of beacon-equipped aircraft. In addition, the BTD shall detect and report civil emergency Mode 3/A codes 7500, 7600, and 7700 and military emergency (four code trains in trail) in a manner so that no more than one false emergency report is reported per 48 hours, averaged over a 30-day period during these same conditions.

3.4.3.5 System operation.- Continuous, unattended operation of the radar system over the range of the service conditions (paragraph 3.3.2) is required.

3.4.3.6 System data delays.- Data transmission delays as specified herein shall be attained under peak capacity conditions of paragrap 3.4.3.2 and are referenced to antenna azimuthal position relative to a target at antenna peak of beam (or boresight).

(a) Overall data delay from antenna boresight to transmission of digital target report from C&I (paragraph 3.12.4) shall not exceed .14 seconds.

(b) ASR-9 when operating without Mode S, the overall data delay from antenna boresight to target report transmission from the SCIP in CD/ASR-9 and SRAP/ASR-9 format shall not exceed .48 seconds.

(c) ASR-9 when operating with Mode S, the overall data delay from antenna boresight to target report transmission from the SCIP in CD/ASR-9 and SRAP/ASR-9 format shall not exceed .78 seconds.

(d) Overall data delay from antenna boresight to analog target centroided position on a PPI display (modem delay included) shall not exceed the following for modes 1 through 4 listed in paragraph 3.12.7.2(a)(2):

1. Mode 1, 1.74 seconds
2. Mode 2, 2.1 seconds
3. Mode 3, .59 seconds
4. Mode 4, .89 seconds

3.4.4 Computer program.- The contractor shall deliver all operational, support, and test software programs including program listings required by this specification. The contractor shall also provide all software programs used to develop test data, technical design data, or documentation data required by this specification. In addition, the contractor shall provide all software programs necessary to load, analyze, modify, reassemble, and reproduce the systems source programs and/or firmware. The software shall be modular such that it shall be possible to make relatively major changes without severe impact on the remainder of the system software. The functions specified in this specification do not fully describe validity checking or error detection/correction procedures. The contractor shall incorporate such procedures in his computer programs in accordance with good programming practice. The realization of irrational numbers, transcendental functions, and stored constants shall make use of appropriate approximations, table lookup and interpolation to avoid costly computational techniques. Implementation of all required programs in the field systems shall be accomplished by use of firmware. Flow charts and fully documented source code listings for all firmware and software shall be provided on a machine readable medium such as a cassette tape or a floppy disk. These programs shall be adaptable to each sensor site via the use of site parameters. These parameters shall be easily changeable at the sensor site via the computer entry device.

3.4.4.1 Firmware.- Computer programs or microprograms that are loaded in a class of memory (Read Only Memory (ROM), Programmable ROM (PROM), or writable control store) that cannot be dynamically modified by the computer during processing shall be considered firmware. Since firmware consists of a composite of programs and memory, documentation of the memory shall be included in the hardware specification to which it pertains, and the computer program or microprogram shall be included in a computer program specification and shall be subject to all requirements stated herein. Contractor developed firmware in this effort shall not reside in masked programmed ROM's.

3.5 Equipment configuration and operating modes.-

3.5.1 Configuration.- The radar system shall be a complete dual channel facility with either channel, when selected, working into a common antenna. The equipment shall incorporate design features to facilitate installation of both radar channels in an existing operational ASR-4, 5, and 6 building. The contractor shall submit his proposed equipment layout to the Government at the time specified in the contract schedule for review and approval by the Government.

3.5.2 Antenna tower.- The radar antenna shall be designed to be compatible with the ASR tower design presently in use by the Government, and described by FAA Drawing Series D-5419.

3.5.3 Operating mode.- The normal operating mode of the system shall be simplex (single channel) operation with range and azimuth gating of the two antenna beams. When the stand-by channel MTD processing subsystem is not required for maintenance, it will be available for processing of the active channel data to provide redundant processing. The standby channel shall be capable of operating into a dummy load independently of the active radar channel for maintenance purposes. In normal operation, when the system is switched to the standby channel, it shall not create any change in the aircraft target, clutter, and weather outline presentations on the air traffic controllers display. It shall be possible to operate the standby transmitter into a dummy load without degradation of the active channel's on-line performance. Switching to the standby channel when it is in the maintenance mode shall be prohibited. Positive indication that the standby channel is in the maintenance mode shall be provided at the radar and remote control panels.

3.6 Reliability and maintainability programs.- The contractor shall plan and implement reliability and maintainability programs in accordance with MIL-STD-785 and MIL-STD-470, respectively. The programs shall be modified as delineated by the reliability, maintainability, and availability requirements stipulated herein. The ASR-9 reliability shall be such that, in conjunction with achievement of the maintainability requirement, the ASR-9 availability requirement shall be met.

3.6.1 Reliability program.-

3.6.1.1 Program plan.- The contractor shall prepare and submit for approval, a reliability program plan in accordance with MIL-STD-785. The reliability program plan shall be submitted in accordance with the contract schedule.

3.6.1.2 Reliability management.- The contractor shall have one clearly identified organizational element which will be responsible for the planning and management of the reliability program specified herein and for insuring its effective execution. The individual designated as head of this reliability management organization shall have the necessary authority and resources, and report at a level having full responsibility for the contract effort to enable him to implement and enforce the requirements specified herein.

3.6.1.3 Program tasks.- The reliability program shall include all the elements of MIL-STD-785 modified as indicated in the paragraphs that follow.

3.6.1.3.1 Design reviews.- The reliability program plan shall include design reviews of each major subsystem, its functions, and equipment. They shall include as a minimum, but not necessarily be limited to, a conceptual or preliminary design review and a critical (predesign release to manufacturing) design review. Other reviews may be called as necessary either by the contractor or the Government. The Government will participate in all reviews. These reviews shall be scheduled as part of each subsystem design review. The contractor shall notify the Government of any design reviews at least ten (10) working days prior to their occurrence and submit complete data packages at time of notification. Items to be covered as a minimum in the conceptual and critical reviews are the tasks that follow.

3.6.1.3.2 Reliability (availability) apportionment task.- The contractor shall apportion the availability requirements of each constituent component of each subsystem. The constituent components shall, as a minimum, be considered as "black boxes" or modules encompassing singular functions or operations only; i.e., amplifier, control flip-flop, regulator, shift register, etc. These apportionments shall be such that they will be in agreement with the functional reliability requirements specified herein. Periodic refinements of the apportionment shall be submitted as the design progresses. Any changes in these apportionments shall be submitted to the Government for review and approval. The approval of any reliability apportionment does not release the contractor from the requirement of meeting the functional availabilities specified herein.

3.6.1.3.3 Reliability modeling task.- Each subsystem shall be reliability modeled and shall identify critical items or paths whose failure will either cause subsystem failures, major performance degradation, marginal operational conditions or departures from the reliability performance characteristics designated herein. From the reliability prediction and the reliability model together with the subsystem operational demands, critical elements shall be highlighted and pinpointed with emphasis upon means of sustaining operation via techniques such as redundancy, overcapacity, and alternate routine, etc., in the event of failure. Further reliability modeling shall be in accordance with both tasks 101 and 102 of MIL-STD-756B.

3.6.1.3.4 Failure Modes, Effects Criticality and Analysis (FMECA) task.- A FMECA shall be performed. This analysis shall be conducted down to the level of modular replacement in normal maintenance (e.g., printed circuit card, power supply module). For each such replaceable item, the dominant modes of failure shall be determined. Based upon these modes of failure, the effect on subsystem performance shall be ascertained. The analysis results shall be employed to evaluate and change the Reliability-Maintainability-Availability (RMA) model, if necessary. The task shall be completed prior to and received at the critical design review and shall be used in preparation of the maintainability demonstration tasks. A preliminary analysis utilizing the derived RMA model shall then be submitted in accordance with the contract schedule and updated thereafter as design changes occur.

3.6.1.3.5 Reliability analysis and predictions task.- Reliability analysis and predictions shall be performed for each element of the RMA model contained in MIL-HDBK-217. The detailed reliability prediction method for stress derating and failure rates shall be in accordance with MIL-HDBK-217, MIL-STD-756B, and RADC-TR-22. Reliability Design Handbook RADC-RDH-376 shall also be used. No other source of failure rate data shall be employed without prior approval of the Government. As part of the detail analysis, part application stress analysis including part local temperatures shall be performed. The failure rate assignments shall be based upon these stress and temperature analyses. FAA-G-2100 Environment II fixed ground, room ambient temperature of 25 degrees C shall be used for the analysis. Additionally, the average part and board temperature shall be estimated based upon the analysis of the attendant thermal environment. The contractor shall also perform measurements on a sample basis as a minimum including at least 25 percent of boards and parts to verify these stress and thermal analyses. Special parts or devices, including; i.e., transmitting tubes, power supplies, rotary joints, modulators, etc., shall be part of the critical design review. A preliminary reliability estimate shall be submitted in accordance with the contract schedule and shall be based upon the environmental criteria specified above. An RMA and Prediction Report shall contain the initial prediction results and shall be submitted in accordance with the contract schedule. An updated prediction report based upon a detailed thermal and electrical analysis of the final system configuration shall be prepared and submitted for the critical design review. The submission shall be at least ten (10) working days prior to the start of the critical design review. The prediction report shall be updated to reflect the current design. Any design changes resulting from or taking place after the critical design review shall require approval of the Government.

3.6.1.3.6 Parts control task.- The contractor shall establish a parts control task that will, to the maximum extent possible, assure utilization of standard parts. The task shall also assure proper application and adequate derating to fulfill the reliability and life requirements specified herein. The contractor shall establish a derating policy for all parts such that during operations at the extremes of Environment II of FAA-G-2100/1, no part will exceed more than 50 percent of its voltage temperature stress as applicable, or for temperature constrained parts, the maximum temperature shall be at least 40 degrees C below the devices maximum operating temperature. Additionally, the limits as given shall be applicable whether the devices are enclosed in a cabinet, bench operated or withdrawn on slides from a rack for servicing. Approval must be granted by the Government before a nonstandard part can be used, reference paragraph 3.20.3.12.

3.6.1.3.7 Failure reporting, analysis, and corrective action task.- The contractor shall establish a closed loop system for reporting all failures. The level of equipment (e.g., circuit board, module, etc.) both manufactured and subcontracted items, for which the contractor proposes to maintain failure record forms shall be included in the technical proposal. As a minimum, failure record forms shall be included in the technical proposal. As a minimum, failures occurring from the time the design is frozen shall be reported with analysis and results. The contractor shall analyze each failure to determine its cause (e.g., equipment manufacturer's design fault, part manufacturing defect, test error, etc.). Failure analysis shall include, to the extent necessary to determine the cause of failure, failed part analysis (including physical and electrical test, x-ray, dissection, and microscopic examination, as necessary) and design analysis (e.g., equipment application stress analysis, circuit tolerance of parts drift). Each analysis shall also include development of corrective action that may be required to prevent failure recurrence. Failure data reports, including analysis results, shall be maintained by the contractor in a central file, to which the Government shall have unlimited access. A copy of an individual report shall be provided on a regular basis, as required by the contract schedule. The Government representative shall be notified of any failure within one (1) working day of its occurrence.

3.6.1.3.8 Reliability demonstration task.- Demonstration of achievement of RMA requirements (paragraph 3.6.3) shall be accomplished by means of the RMA demonstration tests as described in Section 4. Summaries of failures shall be submitted as required by the contract schedule, during all phases of manufacture and test commencing with the preproduction model and all subsequent models. The reporting shall commence with the first application of power and continue through the completion of testing. The summaries shall be so reported that trends, patterns, etc., can be discerned. The failure summaries shall also include the relevancy of the reported failures. Sufficient data shall be included in the summaries to verify the relevant/nonrelevant classification. Examples of some reasons for justifying the nonrelevancy classification are: maintenance induced, operator error, and accidents.

3.6.2 Maintainability program.-

3.6.2.1 Program plan.- The contractor shall prepare and submit for approval a maintainability program plan in accordance with MIL-STD-470 in its entirety, except as modified by this specification. The program plan shall include a milestone chart including program review points, design reviews, analyses and predictions, and maintainability demonstrations. The maintainability program plan shall be included with the system program plan documentation submitted with the technical proposal and updated according to the contract schedule.

3.6.2.2 Maintainability management.- The contractor shall have one clearly identified organizational element which will be responsible for planning and managing the maintainability program. The individual designated as head of this maintainability organization shall have necessary authority and resources and report at a level having full contract responsibility. The maintainability organization may be part of the reliability organization as delineated in paragraph 3.6.1.2.

3.6.2.3 Program tasks.- The maintainability program shall include, but not necessarily be limited to, the following tasks.

3.6.2.3.1 Maintainability apportionment.- The system availability apportionment shall be allocated as maintainability requirements, in consonance with the reliability apportionment to subsystems and major assemblies of the ASR-9 constituting elements of the RMA model. These maintainability equipment apportionments shall be firm requirements but the contractor shall retain the flexibility to meet radar system requirements. These apportionments shall be such that, when achieved, radar system availability requirements are met. The initial allocation shall be submitted as part of the technical proposal and shall be refined and reviewed at the scheduled design reviews.

3.6.2.3.2 Failure Modes and Effects Analysis (FMEA).- In the performance of the FMEA, as described in paragraph 3.6.1.3.4 above, the effects of corrective maintenance action shall be evaluated. In the event that performance of corrective or preventive maintenance, such as replacement of a failed circuit card or module, affects an otherwise operable or functioning circuit, this effect shall be included in the RMA model.

3.6.2.3.3 Maintainability analysis and predictions.- Maintainability analysis and predictions shall be performed for each element of the RMA model. Maintainability analysis shall be in accordance with paragraph 5.2, MIL-STD-470. Predictions of mean corrective maintenance time shall be performed in accordance with Procedure II, Part B, Corrective Maintenance, MIL-HDBK-472. Preventive maintenance requirements shall be determined and the schedule, procedure, and the estimated duration of each preventive maintenance task shall be reported as part of the maintainability prediction results. However, the preventive maintenance schedule shall be limited to not more than 72 hours a year consisting of one technician and not more than 12 visits per year, and shall be accomplished with shutdown of only those elements not required to maintain system operational capability. Any preventive maintenance time which exceeds either the 72 hours per year or 12 visits per year shall be considered as corrective maintenance and counted as down time. A preliminary maintainability estimate shall be submitted as part of the technical proposal. Preliminary prediction results shall be submitted in the RMA and the Prediction Report (paragraph 3.6.1.3.5). Predictions shall be reviewed as part of each design review.

3.6.2.3.4 Maintainability demonstration.- The maintainability demonstration of achievement of the specified mean and maximum corrective maintenance times shall be performed as specified in Section 4.

3.6.2.3.4.1 Module bench repair.- Those printed circuit boards, subassemblies, and other components (also referred to as modules) that are removed from the ASR-9 as a result of a repair action shall be repairable with test equipment as recommended in the list of required test equipment (paragraph 3.7.5).

3.6.3 Reliability and maintainability numerical requirements.- The ASR-9 System shall meet the following reliability and maintainability requirements.

(a)	ASR-9 single channel specified Mean Time Between Failures (MTBF) (exclusive of antenna)	750 hours
(b)	Dual channel ASR-9 radar system availability (including antenna subsystem)	0.999
(c)	System MTR (mean time to restore)	30 minutes
(d)	Subsystem MTTR (paragraph 3.2.9)	60 minutes (no single repair action shall take more than 3 hours)
(e)	Antenna MTBF (including all ancillary items; i.e., rotary joints, slip rings, encoders, etc.)	10,000 hours
(f)	Mean bench repair time	30 minutes
(g)	Maximum bench repair time	1 hour
(h)	Maximum preventative maintenance time	6 hours/month

3.7 Documentation furnished.- Documentation specified in subparagraphs hereunder shall be furnished at the time(s) specified in the contract schedule, in addition to that required by FAA-G-2100/1 or other subsidiary specifications.

3.7.1 System design data.- According to the contract schedule, the contractor shall submit a reproducible and ten copies of the current system design data package. The information contained in the design data shall include:

(a) Block diagrams showing the general operational and functional relationships of the equipment elements.

(b) Information flow diagrams showing the detailed functional operation of the system (including software).

(c) A descriptive text of the equipment design and operation.

(d) A physical description in adequate detail to permit layout and design of site installation plans including size, shape, weight, power requirements, heat dissipation, and recommended spacing for operation and maintenance.

(e) Input/output characteristics and connection data for all signal and power connections to the ASR-9 Systems.

(f) A listing of standard and special tools and test equipment, including performance monitoring test equipment required for installation and maintenance (separate lists).

(g) Usage of the Built-In Test Equipment (BITE).

3.7.1.1 System design deviations.- Deviations from the design contained in the contractor's system design data submitted in accordance with paragraph 3.7.1 will be subject to Government approval and will be considered provided one of the following conditions is satisfied:

(a) The system design data change will provide an improvement in system performance.

(b) The system design data change is eligible for consideration under the terms of the Value Engineering Incentive Clause of the contract.

Requests for change shall be submitted in accordance with FAA-STD-021. The request shall clearly define the change and shall be supported by a cost-comparison analysis and performance analysis. The contractor shall detail the reason for the requested change and shall not include the change in the design until approved by the Government.

3.7.2 Drawings and technical memoranda.- The contractor shall provide to the Government on request any drawings, software programs, and technical documentation produced or used in the design, fabrication, and testing of the equipment. These drawings, software programs and the documentation shall be maintained in an up-to-date state. The contractor shall provide the Government an index of all items. The index shall be initiated on award of the contract and shall be updated monthly for submittal with the monthly progress report.

3.7.2.1 Microfilm copies.- The contractor shall furnish to the Government two complete microfilm copies of all final drawings and documentation prepared for or used on the contract. These drawings and the documentation shall be sufficient to allow complete reproduction of the ASR-9 System. The microfilm reproduction shall include all information supplied by vendors in connection with subcontract materials. The microfilm shall be 35 mm mounted in an aperture card. Each card shall be labeled with the FAA contract number, equipment designated (ASR-9), prime equipment manufacturer's name and drawing or document number. If revisions to the drawings and documentation are made after the original photographing and before contract completion, replacement microfilm for the revised drawings and documentation shall be furnished. The microfilm copies shall be furnished 90 days after delivery of ASR-9 System Serial No. 1.

3.7.3 Power consumption.- According to the contract schedule, the contractor shall provide the Government with information as to the normal operating and peak power loads of the ASR System. Power source is as described in paragraph 3.3. Data furnished shall describe the following four conditions:

(1) Normal operation; i.e., daytime, unattended, summer season and winds less than 20 knots.

(2) Attended/maintenance operation, all equipment in high power maintenance mode, worst case combination of day/night and summer/winter conditions with winds less than 20 knots.

(3) Same as (1) above with winds up to 85 knots.

(4) Same as (2) above with winds up to 85 knots.

As a design goal, the above electrical power loads plus the power load of the following listed equipment, should not exceed the rated capacity of the 50 KW emergency generator normally furnished at the radar site.

Equipment	Power (Watts)
Air Traffic Control Beacon Interrogator	
ATCBI-5 with Digital Defruiter	1,700
Radar Beacon Performance Monitor	700
Obstruction Lights	600
Interior Lights	1,000
Exterior Lights	1,000
Convenience Outlets	500
Air Conditioner/Heat	10,000
TOTAL	15,500 Watts

Power consumption shall be furnished for each unit or cabinet of the ASR System for the four above conditions: transmitter, antenna, receiver, processor, modems, Wx receiver, and RMS. The contractor shall design the ASR-9 System in order to minimize power consumption during all load conditions, particularly under the normal load operating conditions.

3.7.4 Required floor space and weight.- According to the contract schedule, the contractor shall provide the Government with floor space requirements and floor loading of the system on a per cabinet and total basis. Size and weight of the antenna shall also be furnished. The radar and other associated equipment shall be configured to use the minimum possible floor space in the building. For this purpose, the ASR-4 Building (FAA Drawing D-5417) shall be the baseline configuration.

3.7.5 Test equipment documentation.- The contractor shall provide the Government three lists of test equipment and provide individual characteristic data sheets on all listed standard test equipment at the critical design review conference. The test equipment lists are:

a. Standard test equipment for local/remote site performance monitoring, paragraph 3.13, and as required for preventive maintenance routines.

b. Special test equipment, paragraph 3.1(m), that will be provided with each system as required for performance monitoring, paragraph 3.13, and as required for local/remote site preventive maintenance routines.

c. List of maintenance equipment for corrective maintenance and module maintenance which is comprised of special and all standard maintenance equipment required by a central repair facility.

Characteristic data sheets shall be furnished by the contractor during the critical design review conference for each listed standard local/remote site test equipment. It shall describe the measurement function and all characteristics pertinent to this application such as: measurement range, device accuracy, IEEE-488 interface characteristics, program controller interface, sensor requirements, physical size limitations.

The listed maintenance equipment for corrective maintenance and module maintenance shall be that equipment, both special and standard, required to test, troubleshoot, repair, and align circuit card assemblies and replaceable modules to a level that will support the numerical maintainability requirements of paragraph 3.6.3. Additionally, this group of test equipment shall include any equipment that is required for programming/reprogramming of any PROMs or EPROMs used in the ASR-9 unless that capability is inherently built into the ASR-9 System. This group shall also include any equipment required to load, analyze, modify, reassemble, and reproduce the system's source programs and/or firmware.

<u>3.7.6 Remoting cables</u>.- The Government will provide the required telephone lines and/or twisted pair. At the critical design review the contractor shall furnish to the Government information as to the quantity and type of telephone lines or twisted pair to interconnect the ASR-9 and the remote site.

<u>3.7.7 Revision of documentation</u>.- It is recognized that completely accurate information of the type called for in paragraphs 3.7.3 through 3.7.6 above may not be available at the time of original submission. The contractor shall advise the Government of any changes to this data as soon as design refinements permit, and shall provide final, accurate data in accordance with the contract schedule. Revisions and corrections to instruction manuals and trouble shooting manuals shall be in accordance with FAA-D-2494, Part 1 and Part 2.

<u>3.7.8 Radar spectrum engineering criteria</u>.- The requirements of paragraph 5.3 of the Manual of Regulations and Procedures for Radio Frequency Management as issued by the National Telecommunications and Information Administration apply to the radar system described herein. In the event of any conflict between MIL-STD-461 and this criteria, the most stringent requirement shall apply. Any devices used by the contractor to meet these requirements which are not specifically described herein shall be subject to specific Government approval. A preliminary test plan to prove system compliance with these requirements shall be submitted for review concurrent with submission of the test plan required by paragraph 3.7.10 herein.

3.7.8.1 Radio Frequency (RF) filtering.- If any filtering is required to meet the requirements of paragraph 3.7.8, it shall be field tunable over the 2.7 to 2.9 GHz range.

3.7.9.- Not used.

3.7.10 Test plan.- The contractor shall prepare and submit in draft form, five copies of a recommended test plan, in accordance with the contract schedule, for review and approval by the Government. The objective of this plan will be to show how the contractor will demonstrate compliance with this specification. The Government will review and approve or direct the necessary changes to the test plan within 30 days after receipt. The contractor shall incorporate such directed changes and resubmit one reproducible and two copies of the final test plan at least 15 days prior to scheduled equipment tests.

3.7.11 Test reports.- The contractor shall conduct applicable tests in accordance with the approved test plan (paragraph 3.7.10) and record the results for submission to the Government within 15 days after completion of the tests. The contractor shall certify that the equipment covered by each test report submitted for Government acceptance meets all specification and contract requirements. Copies of such test reports shall be distributed as directed by the contract. In addition, one complete copy of the system test plan and a copy of the production and field test reports for each system shall be furnished with each system.

3.7.12 Firmware/software documentation.- Complete documentation of all micro-processor/micro-computer programs and firmware program specifications shall be provided and delivered in accordance with the contract schedule. The documentation shall provide overall information about the total computer program. The design description shall indicate the partitioning of the functional requirements into logically related subsets which are identified with specific subprograms. For each subprogram, a discussion of performance requirements including estimates of program timing and data storage shall be provided. Firmware/software documentation shall be in accordance with Attachment 7 of the contract.

3.8 Antenna assembly.- The antenna shall include a mounting pedestal, dual drive mechanism, rotary joint, a main Transmit/Receive (T/R) feed horn, a passive receive only feed horn, reflector, dual azimuth position generator, circular/linear polarizers, and other features described herein or otherwise needed to comply with the requirements of this specification. The antenna design shall meet all requirements herein while operating with an FA-9764 beacon antenna and under the conditions of Environment III, paragraph 1-3.2.23, FAA-G-2100 except that the wind conditions shall be 0-85 knots operational, with the upper limit extended to 130 knots nonoperational. The contractor shall include procedures in the instruction book for securing the antenna to withstand wind speeds up to 130 knots.

3.8.1 Basic antenna design requirements.- The antenna system described herein shall be designed to include an FA-9764 beacon antenna or equal and to be mounted atop an antenna tower without a radome. Unless specifically excluded, all antenna assembly requirements specified herein shall take into account that normal operation is with an FA-9764 beacon antenna mounted atop the antenna reflector. The design shall minimize antenna maintenance to the greatest possible extent. The antenna system shall be designed to facilitate removal and replacement of any portion of the antenna system except the antenna reflector and the pedestal without the need of a crane or other equipment not furnished as a part of the radar system.

<u>3.8.1.1 Antenna stability</u>.- Vibration of the antenna in the direction of the beam and vibration in a rotational direction shall not degrade the MTD performance factor, when scanning, to less than 60 dB. The figures are for the total motion between transmitter pulse intervals with the antenna rotating and radiating. The contractor shall provide, at the critical design review, calculations, analysis, and measurements to demonstrate specification compliance.

<u>3.8.1.2 Ease of maintenance</u>.- The antenna assembly shall be constructed so as to be easy to disassemble for maintenance and repair at the top of the antenna tower using tools which are supplied. An electric hoist and suitable framework shall be furnished by the contractor to be placed on the maintenance platform and operated by not more than two technicians. This device will be utilized for initial installation and major maintenance in lowering and raising the large items between the maintenance platform and the ground. Provisions shall be made to completely disassemble and remove mechanical parts which are subject to wear or deterioration without removal or disassembly of the reflector, feed horns, or any supporting structures. Design shall include provisions for routine inspection of critical internal pedestal and drive mechanism parts without disassembly.

<u>3.8.2 Antenna mechanical design requirements</u>.- The overall antenna shall be designed to meet or exceed the following requirements:

<u>3.8.2.1</u>.- Not used.

<u>3.8.2.2 Provision for tilting</u>.- The antenna tilt shall be continuously adjustable from the antenna platform such that the underside -3 dB power point on the linearly polarized low beam can be set to any angle between -3 degrees and +3 degrees from the horizontal without any interference between the tilt screw, antenna pedestal, antenna reflector and supports, tower platform, waveguide or any other components. The underside -3 dB point on the low beam elevation pattern shall be the tilt reference point.

<u>3.8.2.2.1 Tilting mechanism</u>.- The tilting mechanism shall be manually operable over its entire range in a period of two minutes by one technician. The adjustment of either a handwheel and gearbox or a ratchet type adjustment. It must be a system permanently affixed to the antenna structure. The tilt adjustment mechanism must be designed such that it will not require more than 20 pounds force to move the antenna tilt from its heaviest position. Mechanical stops shall be provided to limit the travel of

the reflector in the vertical plane at the upper and lower limits of the tilt range. A positive lock shall be provided to prevent slipping at any selected tilt adjustment point within the range. The contractor will be required to demonstrate that the above criteria is met. If the locking mechanism requires a tool to initiate lock or unlock conditions, then such a tool shall be furnished by the contractor and provisions shall be made to store said tool at or near the point of use on the antenna structure. The engagement and disengagement of the lock may require a technician to be on the antenna platform. Adjustment of the tilt setting shall not create any stress on the antenna rotary joint due to waveguide or other attachment.

3.8.2.2.2 Tilt indicator.- A mechanical tilt marker shall be located on the reflector, reflector support, or pedestal. A calibrated scale providing angular readings in increments of 0.1 degree shall be provided to indicate the antenna electrical tilt. The markers indicating increments of 0.1 degree and the spacing between shall be easily distinguished. The tilt indicator shall show the tilt of the -3 dB power point of the main beam to an accuracy of 0.1 degree at 2800 MHz. A means of checking the tilt indicator accuracy against a readily determined physical tilt of the antenna reflector shall be provided.

3.8.2.2.3 Tilt chart.- A permanent weatherproof type graph or chart shall be attached to each reflector assembly in a conspicuous location to permit correction of the tilt indicator for frequency. The scale of this graph or chart shall be sufficient to determine the electrical tilt to an accuracy of 0.1 degree from 2700 to 2900 MHz. This accuracy shall be verified for at least three frequencies (2700, 2800, and 2900 Mhz) during antenna testing.

3.8.2.3 Drive motor safety switch.- A weatherproof safety switch shall be provided to be mounted on the maintenance platform. This switch shall directly open the primary power circuits to both antenna drive motors. The operation of the safety switch shall also disable the HV on the transmitter connected to the antenna. It shall be located such that unlocking the access door to the antenna tower deck cannot be accomplished without first shutting off power to the drive motors. Key action shall be required to operate the safety switch to either the ON or OFF position. It shall not be operated by closing the access door, or be subject to accidental operation. The safety switch contacts shall be designed to handle the full start current of antenna drive motors so that the switch may be actuated and deactuated without damage. A weatherproof, key operated, High Voltage (HV) bypass switch shall be provided near or on the safety switch. On-off switches, separate from the safety switch, shall be provided for each drive motor on the pedestal maintenance platform and the radar building. The on-off switch on the maintenance platform shall have priority. Suitable indicator lamps shall be provided in both the maintenance platform and the radar building to display the operational status of the two drive motors and the safety switch. These status indicators shall also be forwarded to an IEEE-488 bus interface.

3.8.2.4.- Not used.

3.8.2.5 Castings.- Antenna assembly load bearing castings shall be inspected by nondestructive methods such as radiography, magnafluxing, fluorescence, or ultrasonic vibration methods.

3.8.2.6.- Not used.

3.8.2.7.- Not used.

3.8.2.8 Safety wiring.- All internal bolts, screws, and fasteners within the antenna pedestal gear case and the drive motor gear speed reducer shall be safety wired to preclude their loosening or disengagement during operation. As an alternate, devices which have been demonstrated to be superior to safety wiring may be utilized if safety wiring is not feasible.

3.8.2.9 Leveling.- Mechanical jacks, wedges, or similar devices shall be provided to level the antenna pedestal as installed on the tower. For precision leveling purposes, two accessible liquid bubble levels mutually perpendicular or a circular bubble level shall be mounted on the rotating portion of the antenna pedestal. The sensitivity of the bubble(s) shall permit leveling of the antenna to within 0.1 degree. Frequent leveling and adjustments of the antenna, other than that required by settling of the tower foundation, shall not be required.

3.8.3 Test antenna.- A test antenna with appropriate storage container shall be provided with each antenna system. The test antenna shall be mounted in an optimum position on the reflector. The antenna shall be suitable for measuring the transmitter output power and to permit circular polarization measurements. It shall be possible to accurately rotate the test antenna by ±90 degrees in 1 degree increments utilizing the mounting fixture, and to read the antenna position.

3.8.4 Mounting pedestal.- The mounting pedestal shall support the reflector (including beacon antenna), polarizer, feed horns, drive mechanisms, azimuth position generators, and RF rotary joint and other items required for system operation. The pedestal shall be designed to mount on the upper deck of the antenna tower, but shall extend below the deck to facilitate the mounting and maintenance of the drive units, azimuth position generator, rotary joint and other ancillary units from the maintenance platform. The design shall permit routine and minor maintenance and lubrication of the pedestal and drive mechanisms by one technician at the maintenance platform level while the system is operating. Exposed portions of the pedestal shall be weather resistant and dust tight. All supported components shall be easily accessible for servicing without requiring major disassembly of the reflector or other components. The mounting pedestal shall support and rotate the antenna assembly under the service conditions specified in such a manner that the total cumulative effect of vibrations in the mounting pedestal, horn assembly and supports, and antenna on the RF characteristics shall not exceed the limits specified herein.

3.8.4.1 Slip ring assembly.- A slip ring assembly, including sufficient circuits to satisfy all requirements stated in this specification, plus six spares, each capable of handling 120V, 5 amps, 60 Hz, shall be provided. The slip ring assembly shall be reliable and easily adjustable. The slip ring shall have a life characteristic of not less than 50,000 hours with a 95 percent confidence level. The brush life shall be at least 25,000 hours when operating at 12.5 RPM (without brush adjustment). Terminal strips shall be provided to terminate both ends of the slip ring connections. The slip ring assembly may be an integral part of the rotary joint, but in any case the slip rings shall be readily accessible for inspection, adjustment, or replacement.

3.8.4.2 Pedestal overhaul.- The pedestal shall not require any maintenance that would require removal of the assembly from the antenna tower more often than every five years. Provisions shall be made for supporting the rotating portions of the antenna to allow disassembly of components from the pedestal. It shall be possible to replace the main bearing and bull gear in three hours or less (including removal of the rotary joint if required) without disassembly of the reflector or removal of the pedestal from the tower. Provisions shall be made for full support of the rotating portions of the antenna during disassembly of the pedestal. A suitable electric hoist shall be provided as a semi-permanent part of the antenna structure to facilitate removal of the rotary joint, main bearings, and heavy removable portions of the antenna pedestal. The boom of the hoist shall swivel to permit transfer of components to and from the ground from the tower deck.

3.8.4.3 Lubrication.- Oil level check, fill, overflow, and drain plugs, all accessible from the maintenance platform, shall be included. The design shall be such that lubrication and oil level checks may be accomplished without stopping antenna rotation or turning the transmitter HV off. Lubrication shall not be required more frequently than once each 1/2 year of actual operation. The pedestal shall be designed to preclude oil entering the rotary joint, slip ring assembly, or waveguide.

3.8.4.4 Azimuth indication.- Azimuth indication of the antenna shall be provided by a ring attached to the rotating member of the pedestal by means of positioning clamps or screws. The ring shall have legible, permanent marks for every degree and each ten degree increment shall be numbered. An indicating device for the antenna azimuth ring shall be located in an accessible position on a fixed member of the pedestal and shall be clearly visible from the maintenance platform. Provisions shall be made for 360 degrees orientation of the azimuth ring with respect to the antenna pedestal.

3.8.4.5 Braking provisions.- A manually operated brake or lock shall be provided for the purpose of holding the antenna in any fixed azimuth position, under the conditions of paragraph 3.8, once the antenna rotation has ceased.

3.8.4.6 Factory run-in test.- A 168-hour factory run-in test shall be conducted on each pedestal and installed rotary joint with a load applied that adequately simulates the antenna operating under normal test conditions. Type test antennas shall, in addition, be run for 72 hours under worst combinations of environmental conditions in order to determine any mechanical difficulties that may exist. Measurements of power input variation, temperature rise of critical parts of the pedestal and drive mechanisms, observations of noise, vibration and oil leakage, azimuth data accuracy, and other pertinent data shall be recorded for each unit during this factory test to insure compliance with the specification.

3.8.4.7 Antenna mounting.- The antenna pedestal shall be designed for installation and mounting upon towers up to 77 feet in height. The Government will supply the tower drawings required upon request within 60 days after contract award.

3.8.4.8 Alternating Current (AC) power receptacle.- Convenience outlets with weather tight covers shall be provided on or adjacent to the antenna pedestal and on the maintenance platform near the drive units and energized with 120V, 60 Hz, AC power. The power energizing the outlet shall be independent of the antenna rotation ON-OFF switches and the antenna safety switch. Outlets shall be installed in accordance with the National Electrical Code and shall be of the Ground Fault Interrupter (GFI) type. GFI receptacles shall be 15 amperes, 120V, duplex, specification grade, UL Group I, Class A, and shall be 3M/GFI 2701, Pass and Seymour #1591, Square D #GFR-115-1, or approved equal.

3.8.5 Drive mechanisms.- Two separate drive mechanisms shall be employed. Each antenna drive mechanism shall consist of a drive motor, gear train, slip clutch, and mechanical linkage to the rotating portion of the pedestal. The antenna shall rotate continuously in a clockwise direction through 360 degrees in the horizontal plane at a speed of 12.5 RPM $\pm$ 10 percent over the service conditions specified. Rotation rate under normal test conditions shall be 12.5 RPM (+5 percent, -0 percent). Each drive motor shall employ a separate contactor, and the design shall be such that one drive mechanism may be disengaged by shutting down the antenna for 60 seconds or less. It shall be possible to replace the failed drive from the underside of the pedestal while the system is in operation. The replaced drive shall be capable of being re-engaged by shutting down the antenna for a maximum of two minutes. Each drive mechanism shall have separate pinion gears, and shall mount on opposite sides of the main bull gear (on a line passing through the center of rotation). Both drive mechanisms are normally energized; if either drive unit should lock or other failure occur, it shall automatically disengage and the second unit shall drive the antenna. Each drive unit shall be capable of starting and driving the antenna under all extremes of service conditions except for wind, which shall be 40 knots. The design shall be such that strain due to misalignment of the power train bearing and drive shafts shall be relieved, with no damage occurring due to misalignment. The antenna drive system shall be designed to minimize power consumption under all load conditions, particularly under the normal lightly loaded operating conditions.

3.8.5.1 Lubrication.- The drive mechanism shall not require lubrication more frequently than once each 1/2 year of actual operation and shall not require major overhaul (such as replacement bearings or gears) more frequently than every five years of actual operation. The design shall be such that lubrication may be accomplished from the underside of the drive mechanism without stopping antenna rotation.

3.8.6 Rotary joint.- A six section rotary joint shall be provided, three sections of which shall be utilized for the primary radar operating in the frequency range of 2700 MHz to 2900 MHz, the other three for a beacon or Mode S System operating in the frequency range from 1025 to 1095 MHz. All sections of the rotary joint shall transfer energy without change of polarization and with negligible attenuation throughout the 360 degrees rotation of the joints.

3.8.6.1 Operating characteristics.-

	"S" Joints 1, 2, & 3	"L"* Joints 4, 5, & 6
Frequency Range	2.7 - 2.9 GHz	1026 - 1034 MHz 1085 - 1095 MHz
Peak Power (Unpressurized)	Peak Transmitter Power (Joint 1) 1.0 KW (Joint 2 & 3)	5 KW
Duty Cycle	0.0012	0.05**
Nominal VSWR	1.2:1	1.2:1
VSWR (Max. change over 360 degrees rotation)	0.05	0.07
Input/Output Connector	Waveguide (Joints 1 & 2)	Coaxial Type N, female (50 OHMS)
Phase Shift (Max. excursion for 360 degrees rotation)	5 degrees	5 degrees

* With a 1.0 microsecond (between 50 percent points) input pulse, with 55 nanosecond rise and fall times, the output shall be within -15 percent of the input peak amplitude and the rise and fall times shall not exceed 60 nanoseconds (10 and 90 percent points).

** The Duty Cycle may be as high as 20 percent for a 4 millisecond period at 2.5 KW. Other duty cycles possible are 1 percent at 5 KW, 2.5 percent at 2.5 KW, and 5 percent at .5 KW.

	"S" Joints 1, 2, & 3	"L"* Joints 4, 5, & 6
Maximum Phase Shift Between any Channel over 360 degrees Rotation	-	5 degrees
Attenuation (MAX)	0.2 .dB (Joint. 1) 0.5 dB (Joint 2) 0.75 dB (Joint 3)	0.75 dB
Maximum Loss Difference Between any Channels	-	0.2 dB
Maximum Additional Loss Variation with Antenna Rotation Between any Channels	-	0.05 dB

3.8.6.2 Isolation.- The isolation between each rotary joint section and all other rotary joint sections shall be 50 dB or better.

3.8.6.3 Rotary joint finish.- If the rotary joint is of brass composition, the RF portions of the joints shall be gold plated or shall be first silver plated and then rhodium or palladium flash plated. If the rotary joint is of aluminum alloy, it shall be chemically treated to protect against corrosion.

3.8.6.4 Mechanical requirements.- Finger stock or like material shall not be utilized as a mechanical joint that is subject to movement during rotation. The rotary joint shall have integral bearings and shall not depend on the pedestal for the alignment of the choke joint(s).

3.8.6.5.- Not used.

3.8.6.6 Lubrication.- Lubrication of the rotary joint shall not be required more often than once a year of operation.

3.8.6.7 Maintenance provisions.- The rotary joint shall be designed to permit two radar certified technicians to completely remove and replace the rotary joint in 45 minutes or less. Removal of the rotary joint shall be accomplished by utilizing the hoist that is furnished for pedestal bearing

* With a 1.0 microsecond (between 50 percent points) input pulse, with 55 nanosecond rise and fall times, the output shall be within -15 percent of the input peak amplitude and the rise and fall times shall not exceed 60 nanoseconds (10 and 90 percent points).

removal. The removal of the rotary joint shall not require disassembly of the pedestal other than removal of cover plates, etc.

3.8.7 Reflector.- The reflector material shall be welded or permanently attached by other means to the antenna frame in such a manner as to produce a positive mechanical and electrical bond to preclude RF arcing between the reflector and frame. The reflector shall be suitably contoured to provide the radiation pattern specified. The reflector assembly shall include, as a permanent part of the backside structure, a vertical ladder and a foot hold and handholds across the extremities of the reflector for access to service the beacon antenna. Supports and trusses for the reflector and feed system shall not interfere with the electrical performance of the assembly.

3.8.7.1 Contour deflection.- The design and fabrication of the reflector shall be such that it meets the following conditions:

(a) When first detached from the tooling fixture so that no support is provided by the fixture, and with the reflector in its upright (operating) position, deviation of the surface contour from the true (design) contour shall not exceed ± 1/8 inch and additionally, a field contour measurement capability shall be provided that can measure surface contour to ± 1/4 inch.

(b) Under static loading to simulate the combined effect of 12.5 rpm rotation rate, 1/2 inch radial ice and 85 knot wind (maximum operate condition) the deviation from the static curvature shall not exceed a value that is ± 3/8 inch at center and increases linearly to a value of ± 3/4 inch at tips, and the deviation in radial distance from focal point to top of reflector in the symmetrical centerline vertical plane shall not exceed ± 1/2 inch from the true (design) distance.

(c) Under static loading to simulate the combined effects of 1/2 inch radial ice and 130 knot wind (survival conditions) the reflector shall survive without damage and, after removal of the loading, deviation of the reflector surface contour from the true (design) contour shall not exceed ± 1/4 inch.

The simulated loadings above shall be determined to include the loadings caused with beacon antenna installed per paragraph 3.8.7.4. The removable section of the reflector surface utilized for the test horn shall be removable from the rear and shall not distort the reflector contour when in place to the extent that antenna performance is affected.

3.8.7.2 Contour jigs, fixtures, templates.- All templates and jigs used for manufacturing and inspecting the reflector contour shall be constructed of metal. The jigs, fixtures, templates, or other devices used to fabricate and check the antenna contours shall be subject to approval by the Government and shall become the property of the Government upon completion of fabrication of the last antenna reflector on the contract.

3.8.7.3 Field check provisions.- Equipment, instructions, appropriate storage container, data for checking the position of the feedhorns, and inspecting the reflector contour for possible change or damage shall be provided with each antenna. As a minimum, a telescope and folding scale shall be provided as special test equipment for field check of feedhorn position and reflector contour. A telescope is not required for azimuthal antenna alignment provided that a visual alignment device (e.g., gunsight) is built-in or permanently attached to the antenna assembly.

3.8.7.4 Beacon antenna provisions.- The structure of the reflector shall be designed to permit the installation of an FA-9764, or similar beacon antenna atop the reflector. The weight of the beacon antenna will not exceed 700 pounds total. Adequate, adjustable mounting provisions shall be supplied for the beacon antenna. Provisions shall be incorporated to permit proper leveling and alignment of the beacon antenna about the three coordinate axes. The design shall permit field installation of the beacon antenna with the radar antenna reflector in place on top of the tower. The beacon antenna shall be mounted and positioned above the radar antenna reflector so that negligible derogation of the beacon antenna pattern results and all other specification requirements herein are achieved, either with the beacon antenna mounted, or not mounted, in position. A one-time test shall be performed by the contractor to prove that the antenna patterns are not adversely effected by each other. Connectors and cable shall be supplied for connecting the beacon sections of the rotary joint to the input of the beacon antenna. The physical structure of the radar antenna shall be capable of handling this load under all operating and nonoperating extremes of the service conditions of paragraph 3.8.

3.8.7.4.1 Antenna support pads.- The support pads shall accept the beacon antenna. Provisions shall be made to permit easy disconnect of the coaxial connector at the beacon antenna to allow testing of the cable without the necessity of removing the beacon directional antenna or changing the support alignment. There shall be no mechanical interference between the antenna structures.

3.8.7.4.2 Radar/beacon directional antenna alignment.- The structural rigidity of the beacon antenna support pads shall be such that while operating at 12.5 rpm, the maximum power point of the azimuthal radiated beam of the beacon antenna shall be no more than 0.1 degree from the correct position of the maximum power point of the azimuthal radiated beam of the primary radar.

3.8.7.4.3 Beacon antenna tilt.- The mounting pads for the beacon antenna shall be level when the radar antenna is set for 0 degree electrical tilt. Provisions shall be made to level the beacon antenna support pads to within $\pm.5$ degrees of the horizontal ground plane with the radar antenna tilt (low beam) at any angle between -3 degrees and +3 degrees.

3.8.7.5 Antenna materials and finish.- The antenna assembly, including all exterior RF plumbing and waveguide, paragraph 3.14, shall utilize materials, coatings, and finishes which are inherently resistant to a corrosive environment. That is, an environment with a salt environment, 5 percent salt concentration by weight, or an environment with industrial pollutants (smog) of sulphur dioxides and/or nitric oxides. The contractor shall describe the materials, coatings and finishes that he proposes to use for the antenna assembly and shall provide data to support a 20-year life expectancy for the antenna system. The use of ferrous materials in the mounting pedestal shall be deemed standard material. Materials for any portion of the reflector and dual feed horns other than those specifically allowed by paragraph 1-3.15 of FAA-G-2100/1 and considered as standard material shall require written approval of the Government. The color of the exterior finish of the antenna assembly shall be international orange, color number 12197 of FED-STD-595. For comparative purposes, the antenna assembly life expectancy data furnished by the contractor for materials, coatings, and finishes he intends to use shall be compared to that for the following:

(a) Aluminum alloy materials such as 1100 or 6061-T6.

(b) Zinc chromate wash primer per MIL-C-8514 or chemical film per MIL-C-5541, Type I or II, Grade C, Class 3.

(c) Epoxy primer per MIL-P-23377 or equivalent, thickness .0007 inches maximum.

(d) Top coat, Type II, Urethane, Aliphatic Isocyanate per MIL-C-83286; color International Orange, color number 12197 per FED-STD-595, thickness 0.0020 $\pm$ 0.0006 inches.

3.8.8 Azimuth position data system.- The azimuth position data system shall include devices on the antenna to generate azimuth data and the necessary amplification and processing circuitry to meet the requirements specified herein. The azimuth position data shall interface with other equipments at the local and remote site. Active circuitry will be located at the antenna only if absolutely necessary; Government approval is required.

3.8.8.1 Dual system requirement.- The azimuth position data system shall be composed of two complete and separate systems, selectable by each ASR channel and the weather channel. The azimuth data systems shall consist of two separate azimuth pulse generators. Two separate power supplies shall be provided, one for each data source. These redundant azimuth data sources shall operate independently such that failure or removal of one unit shall not interfere with proper operation of the other unit or of the antenna drive system, or of the channelized ASR systems. Either generator shall be removable without interfering with the alignment of the other. The power for the two azimuth pulse generators shall be connected through separate circuit breakers to the power distribution circuitry.

3.8.8.2.- Not used.

3.8.8.3 Azimuth pulse information.- Each Azimuth Position Data (APD) system shall provide two separate sets of ARP and two sets of ACP representative of the azimuthal position of the antenna. A loss of one unit shall not deteriorate the second unit output data during its rotational cycle. Each system shall provide a total of 4,096 and 16,384 equally-spaced ACP and one ARP for each 360 degrees rotation of the antenna. The 16,384 pulses shall be provided as an isolated output at the local site for future use, an output approximating a sine wave is acceptable. The pulse-to-pulse jitter of the azimuth change pulse shall be no greater than ±10 percent of the nominal spacing, and the azimuth reference pulse jitter shall be no greater than ±20 percent of the azimuth change pulse spacing. The output characteristics of ACP and the ARP derived from the APG shall meet the requirements specified herein.

<u>3.8.8.3.1 Azimuth Pulse Generator (APG)</u>.- The ARP and ACP signals shall be generated by sensing the position of rotating elements of the antenna. The method used shall provide an accurate and reliable source of azimuth information. Provisions shall be made to electronically preset the ARP's in each APG system such that timing of the ARP in each unit may be matched ±0.5 ACP after replacement of either azimuth sensor without mechanical adjustment. Incandescent lamps shall not be used as light sources.

<u>3.8.8.3.1.1 Operational and mechanical requirements</u>.- The APG components of the antenna assembly shall be designed for continuous and reliable operation over the temperature range of -50 degrees C to +70 degrees and 5 percent to 100 percent humidity. Preventive maintenance, including lubrication and adjustment, shall not be required more frequently than once each year of actual operation. Replacement of parts or overhaul requiring more than one-half hour antenna downtime shall not be required more frequently than once every five years of actual operation. The number of electronic components located at the antenna pedestal shall be kept to an absolute minimum. Where replacement of modules (or a complete unit) with a spare can be made with less than ten minutes antenna downtime, the replacement or overhaul interval may be reduced to once every three years of actual operation.

<u>3.8.8.3.2 Azimuth accuracy</u>.- The processed azimuth pulses shall define, by pulse count, the angular position of the center of the radar beam with an angular error not to exceed ±.088 degrees for 4,096 and not to exceed ±.022 degrees for 16,384.

<u>3.9 Antenna Radio Frequency (RF) characteristics</u>.- The RF characteristics of the antenna shall meet all performance requirements over the complete range of frequencies from 2700 to 2900 MHz without substitution of components or adjustments. The antenna shall produce a single transmit pattern, a receive pattern identical to the transmit pattern, and a second receive pattern at a higher elevation angle to provide short-range coverage having a higher signal-to-clutter ratio. The second pattern shall be generated by an additional receive-only feed horn. The requirements specified below are given in terms of one-way power for a linear vertical polarized mode of operation unless otherwise specified.

3.9.1 Power gain.- The gain of the antenna pattern associated solely with the main feed horn in the direction of maximum radiation and reception shall be a minimum of 33.5 dB relative to an isotropic source. The gain of the antenna pattern associated solely with the passive feed horn in the direction of maximum reception shall be 32.5 dB relative to an isotropic source. The insertion loss of the antenna pattern selector shall not be included in this measurement. The antenna shall have a median gain of -10 dB or less relative to an isotropic source measured in the principal radiation plane of the antenna patterns associated with the main and passive feed horns. Median gain is defined as the level over an angular region (in this case 360 degrees of the horizontal plane) at which the probability is 50 percent that the observed or measured gain at any position of the antenna will be less than or equal to that level.

3.9.2 Voltage Standing Wave Ratio (VSWR).- The VSWR for the overall antenna, with the feed horns in place and matched to the antenna reflector, when measured at the input of the waveguide running between the rotary joint and the polarizer, shall not exceed 1.3:1 for either antenna feed path in either the vertical or circular positions of the polarizers. In addition, the voltage standing wave ratio of the feed path associated with the main feed horn shall not exceed 1.4:1 during the transition of the polarizer when switching between linear and circular polarization. Overall VSWR measurements shall be taken continuously over the frequency range of 2700 to 2900 MHz. The measurements shall be made for the optimum setting of the polarizers to cover the complete frequency band. Distorting the waveguide or the addition of dielectric material to individual sections of the RF system to correct the VSWR is prohibited.

3.9.3.- Not used.

3.9.4 Azimuth relative field strength patterns.- The relative field strength of the antenna pattern associated with the main feed horn shall have the following characteristics. The azimuth beamwidth in the principal azimuth plane shall be 1.30 degrees minimum at -3 dB and 4 degrees maximum at -20 dB. From the underside -6 dB power point of the principal elevation plane pattern to 10 degrees in elevation above the principal azimuth plane, the azimuth beamwidth with respect to the maximum power at the same elevation shall be 1.3 degrees minimum at -3 dB and 4 degrees maximum at -17 dB. From 10.1 degrees to 20 degrees in elevation above the principal azimuth plane, the azimuth beamwidth with respect to the maximum power at the same elevation shall be 1.3 degrees minimum at -3 dB and 5.0 degrees maximum at -17 dB. From 20.1 degrees to 30 degrees in elevation above the principal azimuth plane, the azimuth beamwidth with respect to the maximum power at the same elevation shall be 1.3 degrees minimum at -3 dB and 5.5 degrees maximum at -15 dB. From the underside -6 dB power point of the principal elevation plane pattern to 30 degrees in elevation above the principal azimuth plane, the midpoint of each -10 dB beamwidth shall fall within 0.1 degree of the midpoint of its respective -3 dB beamwidth. Similarly, the midpoint of each -15 dB, -17 dB, or -20 dB beamwidth, whichever is specified above, shall fall within 0.2 degree of its respective -3 dB beamwidth. The relative field strength of the antenna pattern associated with the passive feed horn shall have the following characteristics. The azimuth beamwidth in the principal azimuth plane shall be 1.3 degrees minimum at -3 dB and 4.4 degrees maximum at -20 dB. From the underside -20 dB to -15.1 dB power points of the principal elevation plane pattern, the azimuth beamwidth with respect to the maximum power at the same elevation angle shall be 1.1 degrees minimum at -3 dB and 3 degrees maximum at -10 dB. From the underside -15.0 dB to -6.1 dB power points of the principal elevation plane pattern, the azimuth beamwidth with respect to the maximum power at the same elevation angle shall be 1.2 degrees minimum at -3 dB and 4 degrees maximum at -15 dB. From the underside -6.0 dB power point of the principal elevation plane pattern to 0.1 degree below the principal azimuth plane (peak-of-beam), the azimuth beamwidth shall be 1.25 degrees minimum at -3 dB and 4.4 degrees maximum at -17 dB points. From +10.1 degrees to +20 degrees in elevation above the principal azimuth plane, the azimuth beamwidth with respect to the maximum power at the same elevation angle shall be 1.3 degrees minimum at -3 dB and 5.5 degrees maximum at -17 dB. From +20 degrees to +28 degrees in elevation above the principal azimuth plane, the azimuth beamwidth with respect to the maximum power at the same elevation angle shall be 1.3 degrees minimum at -3 dB and 6 degrees maximum at -15 dB. From the underside -20 dB to -15.1 dB power points of the principal elevation plane pattern, the midpoint of each -10 dB point shall fall within 0.20 degrees of the midpoint of its respective -3 dB beamwidth. From the underside -15 dB power point of the principal elevation plane pattern to 28 degrees in elevation above the principal azimuth plane, the midpoint of each -10 dB beamwidth shall fall within 0.10 degrees of the midpoint of its respective -3 dB beamwidth. Similarly, the midpoint of each -15 dB, -17 dB, or -20 dB beamwidth, whichever is specified above, shall fall within 0.20 degrees of its respective -3 dB beamwidth.

<u>3.9.5 Azimuth side lobes</u>.- An azimuth side lobe will be considered to be any lobe not in the back lobe sector. The side lobe levels are specified with respect to peak power in the plane in which the pattern measurement is made. The azimuth side lobes of the antenna pattern associated with the main feed horn shall be down not less than 24 dB in the principal azimuth plane, down not less than 20 dB at +10 degrees above the principal azimuth plane, down not less than 17 dB at +30 degrees above the principal azimuth plane, and down not less than 20 dB at the angle below the principal azimuth plane equal to the 6 dB down point of the principal elevation plane pattern. The azimuth side lobes at other intermediate elevation angles shall be down at least to the extent that their dB values are equal to or greater than that required for them to have a direct linear relationship to the elevation angles between the angle of the underside 6 dB down point of the principal elevation plane and the principal azimuth plane (from -20 dB to -24 dB); to the elevation angles between the principal azimuth plane and +10 degrees above the principal azimuth plane (from -24 dB to -20 dB); and to the elevation angles between +10 degrees above the principal azimuth plane and +30 degrees above the principal azimuth plane (from -20 dB to -17 dB). The azimuth plane side lobes of the antenna pattern associated with the passive feed horn shall be not more than 2 dB greater than those specified for the main feed horn. In addition, the

azimuth plane side lobes of the pattern associated with the passive feed horn shall be down not less than 13 dB at the angle below the principal azimuth plane equal to the -20 dB point of the principal elevation plane. The azimuth side lobes at underside elevation angles between the -20 dB and the -6 dB points the principal elevation plane shall be down at least to the extent of their dB values are equal to or greater than that required for them to have a direct linear relationship to the elevation angles between these two points (from -13 dB to -18 dB).

<u>3.9.6 Elevation relative field strength patterns</u>.- The relative field strength of the antenna pattern associated with the main feed horn in the principal elevation plane shall have the following characteristics. The elevation beamwidth at -3 dB shall be 4.8 degrees minimum. Above the upper half power point, the relative field strength pattern shall be a smooth curve starting at the upper -3 dB point and described in terms of dB down from the maximum power of the principal elevation plane pattern at elevation angles above the principal azimuth plane as follows: 6 dB down at 6 degrees, 9.5 dB down at 12 degrees, 11 dB down at 18 degrees, 12 dB down at 25 degrees, and 15 dB down at 30 degrees. The allowable departure from the above pattern shall be plus no limit and minus 1.0 dB. At an angle of 4.1 degrees below the underside -3 dB power point, the power shall be down not less than 20 dB below the maximum power in the principal elevation plane. Any side lobe on the underside of the beam shall be down not less than 22 dB below the maximum power of the principal elevation plane pattern. The relative field strength of the antenna pattern associated with the passive feed horn in the principal elevation plane shall have the following characteristics. The elevation beamwidth at -3 dB shall be 4.8 degrees minimum. Above the upper half power point, the relative field strength pattern shall be a smooth curve starting at the upper -3 dB point and described in terms of dB down from the maximum power of the principal elevation plane pattern at elevation angles above the principal azimuth plane as follows: 6 dB down at 6 degrees, 9.5 dB down at 12 degrees, 11 dB down at 18 degrees, 12 dB down at 25 degrees, and 15 dB down at 28 degrees. The allowable departure from the above pattern shall be plus no limit and minus 1.0 dB. At an angle of 5.1 degrees below the underside -3 dB power point, the power shall be down not less than 20 dB below the maximum power in the principal elevation plane. Any side lobes on the underside of this pattern shall be down not less than 20 dB below the maximum power of its respective principal elevation plane pattern.

<u>3.9.6.1 Separation between the main and passive feed horn antenna patterns</u>.- The axis of maximum field strength associated with the passive feed horn antenna pattern shall be elevated above the axis of maximum field strength for the antenna pattern associated with the main feed horn by an angle that will result in the underside principal elevation plane field strength of the pattern associated with the passive feed horn falling 14 dB ± 1 dB below the field strength of the underside -3 dB power point of the principal elevation plane pattern associated with the main feed horn. The midpoint of the 3 dB power points of any azimuth plane pattern contained within the specified principal elevation plane pattern for the antenna patterns associated with the

main and passive feed horns shall not differ from the midpoint of the 3 dB power points of the principal azimuth plane antenna pattern associated with the main feed horn by more than 0.1 degree.

3.9.7 Back radiation.- The back radiation for the patterns associated with the main feed horn and those associated with the passive feed horn shall be down not less than 32 dB below the peak of their respective secondary beams in the feed horn spillover area (105 degrees to 125 degrees and 235 degrees to 255 degrees away from the peak of the secondary beam) and down not less than 33 db below the peak of their respective secondary beams in all other areas (back radiation shall be considered to be any radiation in the hemisphere of space bounded between the angles from 90 degrees to 270 degrees to the direction of maximum field strength of the secondary beams).

3.9.8 Horizontal polarization component.- When operating with vertical polarization, the cross (horizontal polarization) component of the antenna for both feeds shall be at or below the same level specified for the vertically polarized side and back lobes within the angular region applicable to these lobes. Within the main lobe of the normal pattern, the cross polarized component shall be down not less than 18 dB at the principal azimuth plane, not less than 16 dB at the underside -6 dB point of the elevation pattern, and not less than 15 dB at 30 degrees above the principal azimuth plane. Within the main lobe of the passive pattern, the cross polarized component shall be down not less than 6 dB at the underside -20 dB power point of the principal elevation pattern, not less than 15 dB at the underside -6 dB point, not less than 15 dB at 28 degrees above the principal azimuth plane, and not less than 16 dB at the principal azimuth plane. The level of the cross polarized component at points not specified shall have values not greater than that required to have a direct linear relationship to the elevation angles between adjacent specified points.

3.9.8.1 Vertical/circular polarization.- The antenna system shall be designed to provide for both vertical and circular polarization of the RF signals. The antenna feeds shall have the same sense circular polarization. It shall be possible to meet or exceed the specification performance requirements without changing either polarizer adjustments after initial settings. The design of the polarizers shall be such that the transmitter HV may be left on during the transition from LP to CP and vice versa. The design of the polarizer associated with the main feed horn and passive feed horn shall provide for the orthogonal circular polarizer signal for use as a weather data output source. The axis of maximum relative field strength for vertical polarization of the antenna for either feed shall not differ from the axis of relative field strength for the vertical components of circular polarization by more than 0.1 degrees in the principal azimuth plane of the main feed, 0.15 degrees in the principal azimuth plane of the passive feed, and 0.2 degrees in the principal elevation plane of both feeds.

3.9.8.2 Phase disturbance due to polarization switching.- The design of the circular polarization feeds and switching assemblies shall be such that when the radar system is adjusted for optimum operation in either the vertical or circular mode, switching to the other mode will not derogate the MTD performance. This requirement applies both during the switching period and following completion of the switching to either polarization.

3.9.9 Integrated Cancellation Ratio (ICR).- The ICR of the antenna for the patterns associated with the main feed horn and the passive feed horn shall be at least 22 dB as measured in the principal elevation plane. The ICR of the antenna for the patterns associated with the main feed horn and passive feed horn shall be at least 22 dB in the principal azimuth plane, 17 dB at an elevation angle of 5 degrees above the principal azimuth plane, 10 dB at an elevation angle of 30 degrees above the principal azimuth plane for the main feed horn and 28 degrees above the principal azimuth plane for the passive feed horn. The ICR shall be at least 17 dB for the normal pattern and 14 dB for the passive pattern at the underside -6 dB one-way power strength of each elevation pattern. In addition, the ICR shall be at least 4 dB in azimuth plane at the elevation angle of the underside -20 dB one-way power strength of the pattern associated with the passive feed horn. The dB value of ICR for azimuth antenna patterns for both the passive and main feed horns at other elevation angles shall be equal to or greater than that required for them to have a direct linear relationship of dB versus angle between each of the points specified. All of the above requirements shall be met over the frequency band from 2700 to 2900 MHz without making any adjustments on the vertical/circular polarizers and feed horns from the one fixed set of adjustments required for the best overall integrated cancellation ratios.

3.9.10 Directional beam squint, frequency.- The midpoint of principal azimuth plane pattern associated with the main feed horn shall remain within ±0.1 degrees over the frequency range of 2700 to 2900 MHz with respect to the midpoint at 2800 MHz. The underside 3 dB point on the principal elevation plane associated with the main feed horn shall remain within ±0.2 degrees over the frequency range of 2700 to 2900 MHz with respect to the underside 3 dB point at 2800 MHz.

3.9.11 Antenna pattern tests.- In accordance with the contract schedule, the contractor shall furnish for Government approval, a detailed description of the proposed test procedure to measure both the vertical and circular polarization patterns specified in the foregoing paragraphs. In addition, he shall present evidence that the test site is sufficiently free from ground reflections, considering the antenna pattern characteristics, to make ICR measurements to an accuracy of ± 2 dB. Government approval is required for the proposed test site. Continuous pattern recording equipment shall be used to record the pattern data. The following subparagraphs furnish additional information concerning the techniques to be used in performing some of the pattern measurements.

3.9.11.1 Vertical polarization pattern tests.- With the polarizers set for vertical polarization, the contractor shall perform the following tests at 2700, 2800, and 2900 MHz.

(a) With the antenna turned on its side, measurements shall be made of the principal elevation plane patterns between 15 degrees below the principal azimuth plane to 35 degrees above the principal azimuth plane. The following azimuth plane measurements shall be made: The principal azimuth plane pattern; the azimuth plane pattern at the underside -6 dB point on the principal elevation plane; and the azimuth plane patterns at +10 degrees, +20 degrees, and +30 degrees (28 degrees in lieu of 30 degrees for the pattern associated with the passive feed horn) above the principal azimuth plane. The azimuth plane patterns shall be measured between 10 degrees to the left and 10 degrees to the right of the maximum power point in the same plane. The above measurements shall be made for patterns associated with the main feed horn and for those patterns associated with the passive feed horn. Azimuth plane pattern measurements shall also be made at the underside -20 dB and -15 dB points on the principal elevation plane pattern for the patterns associated with the passive feed horn. These patterns shall be measured between 10 degrees to the left and 10 degrees to the right of the maximum power point in the same plane. All azimuth plane pattern measurements above the principal azimuth plane shall be made with the antenna mounted upside down. All azimuth patterns measured below the principal azimuth plane shall be made with the antenna mounted upright.

(b) With the antenna turned on its side, the principal elevation plane pattern shall be made for the 360 degrees of rotation for the antenna patterns associated with the main feed horn and with the passive feed horn. With the antenna mounted upright and the principal azimuth plane of the pattern associated with the main feed horn tilted up 2.5 degrees above horizontal, the antenna shall be rotated 360 degrees in azimuth and pattern measurements made in the plane perpendicular to the axis of rotation for the antenna patterns associated with the main feed horn and the passive feed horn. The principal azimuth plane pattern in the vicinity of the peak should be superimposed on these patterns to serve as a reference to measure the side lobe levels, back lobe levels, and antenna median gain.

(c) In addition to the above, for the type test antennas only, azimuth plane patterns shall be made at +5 degrees, +15 degrees, and +25 degrees above the principal azimuth plane. These patterns shall be measured between 10 degrees to the left and right of the maximum power point in the same plane. Measurement of the complete 360 degrees of rotation shall be made for the type test antennas in such a manner as to record the relative field strength of the patterns associated with the main feed horn and with the passive feed horn that would be seen if the principal azimuth plane associated with the main feed horn was tilted up 2.5 degrees above horizontal and the antenna was viewed in 5 degree intervals from elevation angles from +5 degrees above the plane perpendicular to the axis of rotation to +10 degrees above that elevation angle between the top of reflector and the middle of the passive feed horn.

(d) The antenna patterns have been specified based on antenna test facilities that use an antenna mount with an elevation axis above the recording azimuth axis. The azimuth beamwidth measurements shall be adjusted mathematically to provide identical data as would be obtained on a mount with an elevation axis above the recording azimuth axis in the event that a different type of mount is used to make the pattern measurements.

3.9.11.2 Circular polarization pattern tests.- Integrated cancellation ratio measurements and calculations shall be made for those patterns associated with the passive feed horn and the main feed horn. For these measurements the polarizers shall be set for circular polarization. The following is a description of a method of measuring ICR which is acceptable to the Government. Any other method the contractor may wish to use shall be subject to Government approval.

(a) The radar antenna to be tested is to be used as a receiving antenna situated in the far-zone field of a transmitter antenna. The transmitter antenna shall be a parabola at least 10 feet in diameter capable of being continuously rotated mechanically about its electrical axis to change the angle of transmitted polarization. A principal azimuth plane pattern is to be recorded on a graph as the plane of polarization of the transmitting antenna is rotated sufficiently slow to permit accurate tracking by the pattern recorder. The antenna under test shall be simultaneously rotated in the horizontal plane sufficiently slow that recorded ellipticity cycles are close enough together to permit accurate extraction of the data. From this pattern, the ICR in the principal azimuth plane may be readily determined.

(b) To obtain a similar set of patterns in the principal elevation plane, the antenna under test is rotated 90 degrees about its electrical axis. This shall be accomplished by laying the antenna over on its side on the mount. Rotating the receiving antenna in a horizontal plane now sweeps the beam through the elevation pattern of the antenna. The polarization angle is again varied continuously in a manner similar to that for the principal azimuth plane pattern as the antenna under test is slowly rotated on the mount. From these patterns, the ICR in the principal elevation plane may be readily determined.

(c) Pattern measurements for ICR determination in azimuth planes at elevation angles other than the principal azimuth plane shall be performed as follows. The measurements shall be made at the underside -6 dB point of the principal elevation plane and +10 degrees, +20 degrees, and +30 degrees (28 degrees in lieu of 30 degrees for the pattern associated with the passive feed horn) above the principal azimuth plane for the patterns associated with the main feed horn and the passive feed horn. Measurements shall also be made of the azimuth plane pattern at the underside -20 dB and 15 dB points on the principal elevation plane for the pattern associated with the passive feed horn. For those azimuth cuts at elevation angles above the principal azimuth plane, the pattern measurements shall be made with the antenna mounted upside down. The pattern measurements specified in this paragraph (c) shall be made on one antenna selected at random by the Government from each group of five furnished under this specification.

(d) In addition to the above, for the type test antennas only, pattern measurements for ICR determination in azimuth planes shall be performed at elevation angles of 5 degrees, 15 degrees, and 25 degrees above the principal azimuth plane for the patterns associated with the main feed horn and the passive feed horn.

(e) At intervals of approximately one-tenth beamwidth along each of the graphs, the maximum and minimum power obtained as the polarization is changed is tabulated. The tabulation extends to points on either side of the beam where power has fallen to 20 dB below that at the nose of the beam. For ICR determination in azimuth planes at elevation angles other than the principal azimuth plane, the tabulation extends 20 dB below the peak of the beam or to the specified maximum side lobe level, whichever is the higher. The integrated cancellation ratio is equal to:

$$10 \log_{10} \left[\frac{\sum_i (P_i\max + P_i\min)^2 \sin \Theta_i}{\sum_i (P_i\max - P_i\min)^2 \sin \Theta_i} \right]$$

where Pmax and Pmin are the maximum and minimum power measured for each azimuth and elevation angle on the azimuth and elevation patterns and where Sine Θ is the elevation angle measured downward from vertical of the point on the beam being measured, assuming that the nose of the beam associated with the main feed horn is tilted upward at an angle 2.5 degrees above horizontal.

3.9.11.3 Other antenna tests.- In addition to the above measurements, measurements shall be made to demonstrate compliance with the requirements of paragraphs 3.9.1, 3.9.2, 3.9.7, 3.9.8, 3.9.9, 3.9.10, and 3.9.11. Where appropriate, these measurements may be recorded in conjunction with the measurements specified under paragraphs 3.9.11.1 and 3.9.11.2.

3.10 Transmitter-modulator assembly.- The transmitter-modulator cabinets shall include all HV and other power supplies (focus, heater), the modulator and its associated driver and power supply(s), RF driver, klystron output tube, and any control or other auxiliary equipment necessary to meet all applicable requirements specified herein. General construction, electrical characteristics, and performance shall be in accordance with subparagraphs hereunder.

3.10.1 Physical size.- The transmitter-modulator circuitry shall be housed in one cabinet of the height and depth and not exceeding twice the width specified in paragraph 3.20.1. Alternately, separate cabinets whose combined size does not exceed that of the cabinet specified above may be employed if x-ray or RF shielding, cooling or other considerations indicate that multiple cabinets are preferable. If multiple cabinets are employed, cables may be routed directly through the interconnecting walls by means of appropriate feed-throughs and/or connectors, provided that such interconnections comply with the requirements of paragraph 3.19.2. Any other connections shall be at the tops of the cabinets as specified in paragraph 3.20.1.

3.10.2 Transmitter general requirements.- The general characteristics of the transmitter and the transmitted pulse shall be as follows: The transmitter shall be complete with RF circuitry, modulator, power supplies, control circuitry, and any other ancillary items needed to meet the requirements of this specification. The transmitter shall be a gain/phase-stable, gated, high-power, pulse amplifier. The normal operating peak output power shall be that level required to provide the coverage requirements of paragraph 3.4.2.

3.10.2.1 Operating frequency.- The transmitter shall be capable of operating at any frequency from 2700 to 2900 MHz, as determined by the Radio Frequency Generation (RFG) (paragraph 3.11.1). The operating frequency shall be determined by crystal controlled sources. The Government will assign a frequency for each system, and will advise the contractor of the frequency at least 120 days prior to scheduled delivery of the system.

3.10.2.2 Radio Frequency (RF) pulse duration.- The duration of the transmitted RF pulse shall be 1.05 microseconds maximum as measured between the half power points.

3.10.2.3 Stability.- The summation of system instabilities, including the contribution of the transmitter modulator, shall result in system MTD performance meeting the system stability requirements specified in paragraph 3.4.3.1.

3.10.3 Transmitter output tube.- The transmitter shall employ a multicavity klystron amplifier, continuously tunable over the assigned frequency band (2700 - 2900 MHz). The tube shall employ an indirectly heated cathode. The HV beam power supply shall be adjustable to permit adjustment of the output power level. Features shall be incorporated to provide automatic control of the beam voltage at a low value when the supply is first turned on, then to increase the beam voltage to a pre-set level. When the supply is turned off, the voltage shall automatically run down. The klystron "body" shall operate at ground potential. The heater voltage shall be adjustable. Current limiting shall be incorporated in the heater supply to limit the turn-on surge current to 150 percent of normal operating current. Failure of the heater supply shall automatically turn off the beam power supply.

3.10.3.1 Beam focusing.- The klystron beam focusing shall be accomplished by the use of a single electromagnetic coil, mechanically separate from the klystron tube assembly. The electromagnetic coil shall be driven from a separate, variable power supply. The power shall be adequately filtered so that the ripple will not result in amplitude and/or phase modulation of the RF output signal. Regulation of the beam focus power supply shall be adequate to maintain the desired focus coil current over the range of service conditions without readjustment.

3.10.3.2 Transmitter cooling.- The klystron and focusing magnet shall be cooled by means of forced air. The cooling system air flow shall be adequate to dissipate the entire beam power, with RF drive removed. Ducts to the building exterior shall be provided for both air intake and exhaust. Automatic selection between external/internal air for transmitter cooling shall be such as to insure maximum overall energy conservation. In the event the exhaust air is returned into the room, the exhaust air flow shall be directed so as not to impinge on personnel. Manual selection of either internal or external air shall be possible. All exterior ducts shall be filtered, reference paragraph 3.20.3.9.2. Air flow and over temperature interlocks shall be provided to protect the transmitter-modulator assembly. Transmitter cooling air flow shall not be in any way dependent upon the building air conditioner for providing the volume of air required to cool the transmitter.

3.10.3.3 Output window.- The klystron output window shall be maintained near ambient temperature, and shall be capable of withstanding pressurization as specified in paragraph 3.14.

3.10.3.4 Voltage Standing Wave Ratio (VSWR).- The klystron shall meet all performance requirements while operating into 1.2:1 load mismatch and shall operate without damage into a 1.5:1 mismatch. The tube shall withstand a mismatch of 3.0:1 for 15 milliseconds without damage at normal operating power.

3.10.3.5 Mechanical features.- The klystron cavity body structure, cathode/heater, electron gun structure, collector structure, and cavity turning mechanism shall be of integral construction and separate from the beam focusing electromagnet assembly. It shall be possible to install and remove the klystron assembly without disassembly or removal of the focus electromagnet assembly. For purposes of tube installation and replacement, features shall be incorporated for positive positioning of the tube in vertical, lateral, and rotational dimensions. Correct "seating" of the tube shall also accomplish correct and positive connection for the cathode and heater. The klystron output-to-systems waveguide adaptor shall be an integral part of the tube assembly.

3.10.3.5.1 Tuning.- Individual cavity tuning mechanisms shall be provided to permit tuning when the klystron is in its normal operating position. Each control shall also incorporate a digital tuning indicator visible when tuning. Chart(s) shall be furnished plotting tuning indicator versus frequency. The tuning torque shall not exceed 500 inch ounces.

3.10.3.5.2 Ease of maintenance.- The mechanical design of the transmitter system shall assure ease of maintenance of any transmitter component, including the klystron. Any special equipment (such as a hoist required for removal of the klystron) shall be provided. Design shall be such that complete removal and replacement of the klystron and restoration of normal operation can be accomplished in not more than two hours by not more than two technicians. A wheeled cart or dolly designed to store a spare klystron plus a second klystron removed from a transmitter during maintenance shall be provided with each system. The cart or dolly shall be free to rotate in any direction for maximum mobility with smooth travel over a concrete or carpeted floor.

3.10.3.6 Ion pump.- The klystron shall incorporate an ion pump which shall operate continuously when the tube is operating.

3.10.4 Metering.- Metering shall be provided for high-voltage, heater voltage, focus coil voltage, and all critical currents to monitor tube operation. The metering circuits shall incorporate features to preclude erroneous indications resulting from the environment in which they operate. Metering circuits shall be protected in the event of faulty high current conditions or modulator pulse.

3.10.5 Arc protection.- To protect the klystron from arcing, which may occur in the system waveguide, arc detectors shall be incorporated in the system waveguide to initiate removal of the RF drive or modulator pulse. Three arc detectors shall be provided, one located in each channel's waveguide prior to the waveguide switch, and the third shall be located between the rotary joint and the waveguide switch. Suitable indicator lamps located in each transmitter channel shall be provided.

3.10.6 X-radiation shielding.- X-ray shielding shall be provided as required to reduce the radiation to a safe level for personnel working in the vicinity and for klystron adjustments and tuning. A maximum safe level is defined as an exposure capability of 2.0 milliroentgens per hour (1-3.5.4, FAA-G-2100/1).

3.10.7 Transmitter modulator.- The transmitter modulator shall be entirely solid-state and modular in nature. To provide a fail-soft characteristic, the modulator shall consist of identical modules. At least 80 percent of the klystron normal operating power (paragraph 3.10.2) shall be maintained with two modules nonoperational. This shall occur without resorting to any readjustment of klystron RF drive, modulator HV, etc. Temperature derating of critical modulator parts shall be demonstrated as a design qualification test. The rise and fall times and duration of the modulator pulse shall be such as to insure that it completely brackets the RF drive pulse to the output tube, while simultaneously holding the output power drain to a minimum. The modulator shall be capable of providing at least 20 percent more power than is required to produce the normal transmitter output power (paragraph 3.10.2). Timing signals to control the transmitter and modulator shall be provided from the System Timing Unit (STU) (paragraph 3.12.2.1).

3.10.7.1 Interlocks.- All HV portions of the transmitter/modulator cabinet shall be fully enclosed with all access doors fully protected by interlock switches which cannot be bypassed.

3.10.8 Transmitter High-Voltage (HV) power supply.- The HV power supply shall be capable of delivering at least 20 percent more than the average power required to supply the RF output tube with its normal operating power (paragraph 3.10.2). Fail-safe provisions shall be included to automatically discharge any HV capacitors which might endanger the safety of personnel. Electronic regulation circuitry shall be provided to assure operation during alternate CPI operation consistent with specified MTD performance and all other applicable requirements.

3.10.8.1 Voltage adjustment.- The voltage output of the HV power supply shall be controlled by a continuously-variable device having a calibrated control. The output voltage adjustment range shall be sufficient to change the transmitter RF output power over the range of at least from minus 20 percent to 10 percent above normal operating power (paragraph 3.10.2). An adjustable stop on the control shall prevent the output voltage from exceeding the maximum normal operating power.

3.10.8.2 Filtering.- The direct current transmitter HV power supply shall be filtered as required for fulfillment of the MTD system performance requirements of this specification. The input to the transmitter HV power supply shall be filtered such that no transients are reflected on the power line.

3.10.8.3 Inrush current.- With the transmitter HV adjusted to result in the maximum normal operating power (paragraph 3.10.2), it shall be possible to turn the transmitter HV off and on repeatedly without equipment damage or actuation of overload protectors. Immediate satisfactory system performance shall result even though normal operation will utilize the automatic run-up specified in paragraph 3.10.3.

3.10.9 Radio Frequency (RF) drive.- The RF drive circuit shall be capable of supplying 120 percent of the RF drive power necessary for the final klystron amplifier to develop the required output power. Provisions shall be included to permit the driver power level to be readily adjusted. Test points shall be provided to enable viewing the pulsed RF signal at the input, output and at intermediate points using standard test equipment.

3.10.9.1 Klystron Radio Frequency (RF) input circuit.- The RF drive shall be isolated from the klystron input to effectively isolate the RF drive circuit from high input VSWR. A switch shall be incorporated to effectively attenuate the input RF drive when the switch is energized by the waveguide arc sensor circuit specified in paragraph 3.10.5.

3.10.9.2 Frequency tolerance.- Frequency tolerance of the radiated signal, including drift from a cold start over the range of service conditions, shall not exceed $\pm$ 100 parts per million.

3.10.10 Protective circuitry.- Protective circuitry shall be provided as necessary to prevent damage to transmitter parts. This circuitry shall include sensing, control and visual indication of malfunction for the following parameters as a minimum where applicable to the modulator design:

(a) Over voltage
(b) Under voltage
(c) Over current
(d) Under current
(e) Modulator inverse current
(f) Focus solenoid current
(g) Driver inverse current
(h) Driver overload
(i) RF output tube temperature
(j) RF output tube air flow
(k) Bias failure
(l) Solenoid air flow.
(m) Arc Protection

Primary power shall be automatically disconnected from the HV plate supply transformer whenever proper operating conditions do not exist. Protective devices shall be reset by operating either the HV switch manually to the ON position or by an automatic recycling device.

3.10.10.1 Recycling.- An automatic recycling device shall be incorporated which shall be initiated when the protective circuits sense a malfunction. It shall automatically reset the protective circuits, if required, and automatically turn on the HV at least three times, and no more than five times during a sustained malfunction. Following the recycling device action, it shall be possible to apply HV manually with the HV ON switch. The HV ON switch shall also reset the protective circuits, if they do not reset themselves automatically. In the event of loss of primary power for an interval of 15 seconds or less, the system HV shall be capable of being reset without requiring the normal preheat time to recycle.

3.10.10.2 Time delays.- A time delay device shall be incorporated to prevent the application of HV to the modulator until the RF output tube and modulator have been properly preheated.

3.10.10.3 Overvoltage protection.- Metal oxide varistors shall be incorporated to protect components (such as plate transformers, output tube, pulse-forming networks, etc.) from overvoltage. The varistors utilized shall be designed to minimize change in characteristics with age or with the number of overvoltages that might occur.

3.10.11 Metering and indicator lamps.- The following meters and indicator lamps shall be furnished as a minimum:

Meters	Indicator Lamps
a) Operate time	a) HV on
b) Transmitter HV	b) Filament on
c) Transmitter HV current	c) Faults
d) Modulator inverse current	d) Fault recycle
e) Transmitter low voltage power	e) Modulator driver HV on
f) Klystron current/voltage	f) Preheat
	g) Transmitter available
	h) No control
	i) Oil level/Temperature
	j) Waveguide arc

3.10.12 Transmitter-modular pulse monitoring.- Provisions shall be incorporated for viewing, at test jacks, the voltage and current pulses of the pulsed output tube and modulator with calibrated voltage-divider networks and current-viewing transformers.

3.10.13 Klystron oil reservoir.- If an oil reservoir is provided as part of the klystron installation, the oil shall be circulated through a heat exchanger which shall cause the oil temperature to be maintained at a safe operating level. If draining of the oil is necessary for access to tank mounted parts, a mobile oil tank with a reversible pump system, hygroscopic filter, and quick disconnect fittings shall be provided. Also, a means of visually checking the oil level with the transmitter in operation shall be provided.

3.10.14 Klystron oil dielectric strength test.- The klystron oil reservoir shall contain the means to measure the oil dielectric strength.

3.11 Receiver assembly.- The receiver assembly shall include, but not be limited to, receiver/TR devices, receiver STC, antenna RF pattern switch, RF amplifier and waveguide bandpass filter, RF plumbing and circuitry common to the receivers, and the RF generator (STALO, COHO), all housed in a single cabinet of the type specified in paragraph 3.20.1. The receiver assembly shall perform and be designed in accordance with the requirements of sub-paragraphs hereunder and other applicable specification requirements. This unit shall be a stable, sensitive, wide-dynamic-range S-band receiver. It shall employ a multisection input bandpass filter tunable over the range of 2.7 GHz to 2.9 GHz centered at the radar operating frequency. The receiver shall use a PIN-diode modulator operating as a Sensitivity vs Time Control unit (STC) ahead of the RF amplifier to provide controlled attenuation vs range. The receiver shall use a solid-state, low-noise RF amplifier with input limiter protection against the transmitter pulse leaked by the system duplexer. The receiver shall provide a minimum of 20 dB of image rejection of frequencies generated in the mixer. The receiver shall use a mixer following the front end amplifier to convert the input S-band signal to an IF signal which shall be phase detected in two separate detectors (I&Q) and transmitted to the A/D converters and to a bandpass filter/log magnitude detector unit for deriving a normal radar video signal for maintenance purposes. The summation of system instabilities, including the contribution of the receiver assembly, shall result in system MTD performance meeting the system stability requirements specified in paragraph 3.4.3.1.

3.11.1 Radio Frequency Generator (RFG).- The following shall originate in the RFG: the receiver Stable Local Oscillator (STALO); the transmitter output frequency; the Coherent Oscillator (COHO); the RF test signals; and any other low level RF signals required. The radar shall be a coherent system with transmitter output frequency, STALO, COHO, and system timing derived from a master clock. The RFG shall be located in each radar channel and shall be completely solid-state. The RFG shall derive all signals from crystal-controlled oscillators. It shall be possible to operate each unit on at least 200 equally spaced selectable operating frequencies within the 2700 to 2900 MHz band. The number of crystals required shall be held to an absolute minimum. The frequency selection shall be made by means of changing crystals. A meter and metering circuitry shall be provided to monitor the STALO drive signal as a maintenance check.

3.11.1.1 Shielding.- Radiation from the RFG shall not adversely affect radar system performance. The shielding shall be sufficient to prevent any fields of extraneous energy from interfering with the achievement of equipment performance requirements or any deterioration in system performance. Interconnecting cables and leads shall be adequately shielded and filtered to prevent any frequency instability which may result from circuit crosstalk or the transmission of transients from external circuits to the RFG. Shielding shall be in accordance with FAA-STD-020.

3.11.1.2 Adjustment.- Tuning, operating adjustment, or test measurement shall not be required more frequently than once every two months.

3.11.1.3 Stable Local Oscillator (STALO).- A crystal-controlled oscillator, (STALO), shall be provided to generate a local oscillator signal within the frequency, power and stability limits necessary for receiver operation and for mixing with the COHO oscillator signal to produce the transmitter frequency. The STALO shall operate at one S-band frequency and shall be adjustable over the range of 2700-2900 MHz $\pm$ the IF MHz. The output power shall be stable to within $\pm$ 0.5 dB over a 30-day period, and to within $\pm$ 1.0 dB over a 20,000-hour period. The output frequency shall be accurate to within one part in 10^5, and the long-term drift shall be no more than $\pm$ one part in 10^5 per year. The 1 dB compression point shall be equal to or greater than 3 dB above the operating point.

3.11.1.4 Intermediate Frequency (IF) Coherent Oscillator (COHO).- The COHO shall be a stable crystal-controlled oscillator. The output power shall be stable to within $\pm$ 0.5 dB over a 20,000-hour period. The frequency shall be accurate to within one part in 10^5, and the long-term drift shall be no worse than $\pm$ one part in 10^5 per year. The limitation imposed by the COHO in the operating radar system shall not degrade MTD performance at any range. The transmitter output frequency shall be derived coherently from the COHO and STALO signals.

3.11.1.4.1 Coherent Oscillator (COHO) output.- The COHO shall have multiple, isolated outputs with the stability and power level required to properly interface with the phase detectors, STU and any other required clocks and transmitter requirements. An isolated spare output shall be provided for future use and shall be properly terminated.

3.11.1.4.2 Coherent Oscillator (COHO) channel.- The COHO channel shall receive the IF reference signal from the RFG, provide variable input attenuation, bandpass filter the signal, and amplify and divide it to develop two COHO reference signals of equal amplitude and 90 degrees phase difference. These signals shall be used to drive two double balanced, quad-diode phase detectors. The variable input attenuator shall be used to control the reference COHO drive level at the two phase detectors. The nominal level at the input to the phase detectors shall be sufficiently high to support "linear" operation. A bandpass filter centered at the IF frequency shall be used in the COHO channel to isolate this network from out-of-band spurious signals. The 1 dB compression point shall be equal to or greater than 3 dB above the operating point.

3.11.1.5 Transmitter driver.- The transmitter driver frequency shall be derived from the STALO and COHO signals. Suitable circuitry, shall be utilized to develop the frequency and power required to drive the high power pulsed amplifiers located in the modulator/transmitter cabinet. The adjustment of the driver circuitry shall be straightforward, and it shall be difficult to tune the driver to any frequency outside the 2690-2910 MHz band.

3.11.2 System sensitivity.- The contractor shall demonstrate that a distinguishable target (50 percent probability of detection) is produced at the coherent video output whenever a target with a system pulse width is injected prior to the receiver protective device at a level not to exceed -108 dBm. The means for performing this test is included in the test target generator (paragraph 3.13.3).

3.11.3 Noise figure.- The noise figures shall be measured from a directional coupler on the receiver side of the circulator to the output of the IF distribution amplifier. The overall noise figure relative to minimum theoretical noise shall be no greater than that specified over the frequency range of 2700 to 2900 MHz when measured with the transmitter off and the transmission line terminated in the dummy load. Theoretical noise is to be defined as the product of Boltzman's Constant, effective noise bandwidth in Hz and temperature in degrees Kelvin.

3.11.4 Circuit interaction.- All IF and video modules shall be fully shielded and adequate power supply decoupling provided to preclude interaction between IF and video portions of the various receivers. The design of the IF preamplifiers and amplifiers shall be such as to prevent any feedthrough effects. Signal levels from the STALO shall not exceed -60 dBm at the receiver input RF connector under any combination of conditions.

3.11.5 Transmit/Receive (TR) devices.- TR devices shall be employed as necessary to protect the receiver and to insure that the receiver has recovered to within 3.0 dB of its normal sensitivity within 5 microseconds of the firing of the transmitter. The recovery time specified above shall be obtained with the receiver PIN modulator set for minimum attenuation and with the receiver connected to both the passive (high beam) and main (low beam) feed horns. Insertion loss of the TR device be compatible with a system noise figure of 4.1 dB or less. The TR devices shall not require a "keep alive" voltage source, and shall provide full receiver protection from both the transmitter associated with the receiver and the opposite channel transmitter.

3.11.5.1 Bandpass filter.- A bandpass filter shall be provided. The filter shall be tunable over the range of 2.7 to 2.9 GHz. Tuning shall be accomplished by means of accurately calibrated micrometer adjustments. Every bandpass filter shall be calibrated and the micrometer settings for the complete frequency range from 2.7 to 2.9 GHz shall be furnished in the form of a permanent graph that is attached to the equipment near the filter in a readily visible location. The micrometer shall be replaceable and the filter shall meet all the applicable specification requirements after one or more of the micrometers are replaced and the filter is recalibrated. The resetability of the filters shall be such that it shall be possible to repeatedly tune the filter to any operating frequency in the operating range by reference to the graph and have the operating frequency fall within ±1.0 MHz of the center of the passband of the filter. When the filter is tuned, the ripple insertion loss and bandwidth shall be in accordance with the requirements specified herein:

Attenuation	Bandwidth
3 dB	10 MHz minimum
20 dB	28 MHz maximum
40 dB	46 MHz maximum
60 dB	72 MHz maximum
Insertion loss	Compatible with System Noise Figure of 4.1 dB or less
Ripple in passband	0.15 dB maximum

The mechanical mounting of the filter in the system configuration shall be such that a new filter of thirty (30) inches in length (in line, input to output connection) could be inserted without change to any support brackets, mechanical access or ease of removal.

The normal location of the bandpass filter will be after the RF amplifier. The bandpass filter shall be designed such that it can be physically relocated as a site option ahead of the RF amplifier without additional hardware or material. The specified noise figure of 4.1dB or less shall be measured with the bandpass filter installed ahead of the RF amplifier.

3.11.5.2 Sensitivity Time Control (STC)/antenna beam selector.- Sensitivity time control and antenna pattern selection (main or passive) shall be accomplished by means of PIN modulators inserted in the two receive paths between the TR device (3.11.5) and the RF amplifier (3.11.6.1). When biased for minimum attenuation, the resultant insertion loss of the PIN modulators in each receive path shall be as required to be compatible with a system noise figure of 4.1 dB or less for each path. When biased for maximum attenuation, the characteristics of the PIN devices shall be as required to provide the STC and beam isolation functions specified below. Separate and independent STC functions shall be provided in both the high beam (passive) and low beam (main) receive paths for each channel.

3.11.5.2.1 Sensitivity Time Control (STC).- Separate STC control circuitry shall be provided for each receive path. Each STC circuit, by control of the PIN device bias, shall provide time-varying gain characteristics. An STC "OFF" capability shall be provided at the local site for maintenance purposes. The STC characteristics shall be generated digitally. The digital STC generators and the Digital to Analog (D/A) converters may be located in either the receiver or processor cabinet provided performance characteristics are not affected by the location. The STC characteristics shall be generated by adjustable circuits with minimum range of adjustment as follows:

(a) The initial value of receiver attenuation shall be adjustable from the minimum insertion loss of the device to at least 60 dB.

(b) The attenuation shall decrease exponentially from 3/8 - 6nmi at a rate which is adjustable from 0-12 dB/octave in increments of 1dB per octave. Independent control of the slope shall be provided in 1 dB increments in 7 other range zones: 6-8, 8-12, 12-16, 16-24, 24-32, 32-48, 48-60nmi.

(c) The attenuation shall not differ from the curve programmed above by more than 1.5 dB or 5 percent of this STC curve (whichever is greater) for any programmed attenuation up to 60 dB over the range of service conditions.

(d) The Low Beam STC Attenuator shall have the capability of applying maximum attenuation from zero range to 1 nm prior to the shortest range of which the low beam is selected and shall recover to the programmed STC attenuation within the specified STC accuracy by the time the low beam is switched on.

3.11.5.2.2 Receiver blanking.- Receiver suppression, in addition to the STC (paragraph 3.11.5.2.1) shall be provided to prevent evidence of the transmitter pulse in the output of the receiver. This feature shall not affect the receiver recovery time.

3.11.5.3 Antenna pattern selection.- The antenna pattern selection function shall be accomplished by biasing the PIN modulators (paragraph 3.11.5.2) to act as a single-pole-double-throw switch; i.e., one modulator is biased "off" while the other is biased "on", with provisions to reverse the states simultaneously. The output of the "on" modulator shall be routed to the RF amplifier input. The STC functions shall not be adversely affected by the antenna pattern selection function; nor shall the insertion loss of the PIN modulator which is biased "on" be increased above the level specified in paragraph 3.11.5.2. The isolation between the two receive paths shall be not less than 30 dB; i.e., the signal level from the "off" path shall be at least 30 dB below the signal level from the "on" path as seen at the input to the RF amplifier. This isolation requirement applies for all the STC settings. No false alarms shall be generated as a result of switching between beams in range or azimuth.

3.11.5.3.1 Antenna pattern selector.- The antenna pattern selector shall initiate the switching action of the antenna pattern RF switch. The point or points in radar range where this switching action is initiated shall be determined by one of the following selectable sources:

(a) An internal switch designated high beam/low beam which shall select either the energy received from the passive feed horn (high beam) or the energy received from the main feed horn (low beam).

(b) An internally generated gate that is adjustable in increments of 1/2 mile or less from 0 to 60 miles in range, to switch from the high beam to the low beam.

(c) An external input jack -- The RAG, specified in paragraph 3.15, shall be connected to this input. Any azimuth beam switching shall be synchronized with the end of a CPI. It will allow switching from high to low beam or low to high beam depending on the location of the windows.

3.11.6 Receiver.- The ASR-9 shall include receivers with the dynamic range and linearity necessary to drive the A/D converters to saturation without introducing harmonics or cross products deleterious to MTD performance. The receivers shall include the following functions.

(a) RF Amplifier (paragraph 3.11.6.1)

(b) Signal Mixer (paragraph 3.11.6.2)

(c) IF Pre-Amplifier (paragraph 3.11.6.3)

(d) IF Amplifier (paragraph 3.11.6.4)

(e) Phase Detectors (paragraph 3.11.6.5)

(f) Video Amplifiers (paragraph 3.11.6.6)

(g) A/D Converter (paragraph 3.11.6.7)

(h) A/D Output Interface (paragraph 3.11.6.8)

Receiver suppression (in addition to the STC specified in paragraph 3.11.5.2.1) shall be included to suppress transmitter pulse feedthrough. This feature shall not affect the receiver recovery time. The output video level of the receiver into the A/D converters shall be adjustable to insure that the RMS noise level can be set from one quantum level to five quantum levels (0 to +14 dB). The 1 dB compression point for the receiver shall be equal to or greater than 3 dB above the level required to drive the A/D converters into saturation. The receiver must introduce less than -55 dB intermodulation distortion (odd order terms) when subject to a two tone test. The two test tones shall be 3 dB below the level required for peak output of the A/D converters.

3.11.6.1 RF amplifier.- An RF amplifier of the following minimum characteristics shall be provided:

(a)	Operating frequency	2.7 to 2.9 GHz
(b)	Instantaneous bandwidth (1 dB)	200 MHz
(c)	RF Gain (minimum)	15 dB
(d)	Input signal for 1 dB compression of output signal	-20 dBm (Minimum)
(e)	Noise figure	Compatible with System Noise Figure of 4.1 dB or less

Amplitude and phase stability of the RF amplifier (particularly short term stability) must be adequate to result in the specified system performance. The RF amplifier shall provide a minimum of 35 dB active isolation from the antenna pattern selector and the mixer (3.11.6.2). If used, temperature stabilization shall employ solid-state, proportional control. The design of the temperature controller shall be fail-safe, in that no mode of failure can result in high temperature burnout of any part of the RF amplifier. A means of checking for proper operation of the temperature stabilization system shall be provided.

3.11.6.2 Receiver signal mixer.- A balanced diode signal mixer shall be provided. The mixer shall not saturate on any signal that is not saturated in the RF amplifier. The output of the mixer shall be the IF signal which is obtained by mixing the received RF signal with the STALO signal (paragraph 3.11.1.3). The IF output of the mixer shall be essentially free from spurious components that might excite the preamplifier or IF circuits.

3.11.6.3 Receiver Intermediate Frequency (IF) preamplifier.- An IF preamplifier shall be installed in the signal receiver path following the signal mixer. The preamplifier shall be matched to the signal mixer and located physically close to the signal mixer. The receiver IF preamplifier shall accept the output from the signal mixer and provide the necessary amplification, dynamic range, and bandpass characteristics to drive the IF amplifier. In addition, the preamplifier shall provide two spare isolated outputs. The unused outputs shall be properly terminated.

3.11.6.4 Intermediate Frequency (IF) amplifier.- The IF amplifier shall receive the IF signal from the IF preamplifier, provide variable input attenuation, bandpass filter the signal, amplify the signal, drive a passive two way power divider, and then drive two high power, double balanced quad diode phase detectors. Input attenuation and gain adjustments shall be provided to assure that the IF amplifier is optimally adjusted for operation in the linear region, while in conjunction with an adjustable gain in the video amplifiers (if used), the overall receiver gain is adjusted such that the RMS receiver noise level at the input of the A/D converter is adjustable from one quantum level to five quantum levels of the A/D converter. A bandpass filter centered at the IF frequency shall be used to filter out of band spurious signals. The filter shall be consistent with the requirements of paragraphs 3.4.2, 3.4.3.3.1, 4.3.7, and 4.3.8. In addition, any side lobes generated by a target 70dB above noise shall be at least 60dB down.

A linear, wide band amplifier following the filter shall be used to raise the signal level to a point sufficient to drive the two way power divider and phase detectors. The IF amplifier shall include a selectable broadband (10 MHz) IF limiting ahead of the IF bandpass filter for use at sites with excessive clutter returns. The 1 dB compression point of the IF amplifier shall be equal to or greater than 3 dB above the operating level. A log-magnitude detector shall be included to provide log normal video to be displayed on the maintenance display.

3.11.6.5 Phase detectors.- The phase detectors shall receive IF signals from the IF amplifier two way power divider, coherent reference signals (COHO) from the COHO channel (paragraph 3.11.1.4.2) and shall provide In-phase (I) and Quadrature (Q) bi-polar video signals to the video amplifiers. The output of the phase detectors shall be filtered with a low pass filter. Response at the IF frequency and higher frequencies shall be at least 70 dB below the video signal level which causes saturation of the A/D converters.

3.11.6.6 Video amplifiers.- Video amplifiers shall be provided following the phase detectors, if required to match the input requirements of the A/D converters. Highly stable, balanced video amplifiers shall be provided. The long term DC offset stability shall be such that the offset voltage developed is less than 1/4 LSBs of the A/D converters under all environmental and temperature conditions specified.

3.11.6.7 Analog/Digital (A/D) Converters.- The A/D converters shall be high-speed, 12 bit units capable of operating at sampling rates specified in paragraph 3.12.1.3, and shall have processing delays equal to or less than 400 nsec. This unit shall introduce differential processing delays no greater than 100 nsec, and shall have an aperture time equal to or less than 100 picosec.

3.11.6.8 Analog/Digital (A/D) Converter output interface. - The A/D output interface shall provide digital signals to the DSP. It shall also provide a set of holding registers to sample the A/D outputs at specific times. The holding registers' outputs shall be available to external test equipment. Two modes of sampling shall be provided, one using the pulses of SGP (paragraph 3.12.2.7(d)) and the other using the A/D encode command pulses of SGP (paragraph 3.12.2.4(a)). The sample A/D outputs shall be used for system tests (such as the SGP tests) or for monitoring. This interface shall have a set (2) of fast D/A converters to provide analog signals to external monitoring equipment for observation of the digitized I&Q receiver signals. These D/A's shall be connected to the holding registers. The resolution of these D/A's shall be 2^{-10} or better. Their settling time shall be less than 200 nsec and their outputs shall be filtered.

3.11.6.9 In-Phase and Quadrature (I&Q) Phase Signal accuracy.- Amplitude and phase differences between the I&Q channels (measured at the output of the A/D converters) will generate image frequencies. The image frequency generated by a signal 60 dB above the noise shall be at least 57 dB down.

3.12 Moving Target Detector (MTD) processing subsystem.-

3.12.1 Moving Target Detector (MTD) general requirements.- The MTD hardware, consisting of a system timing unit (paragraph 3.12.2), digital signal processor (paragraph 3.12.3), a correlation and interpolation processor (paragraph 3.12.4), a surveillance processor (paragraph 3.12.5), and a surveillance and communications interface processor (paragraph 3.12.7) shall be provided in accordance with the contract schedule. An MTD processing subsystem shall be provided for each radar channel.

3.12.1.1 Redundancy of Moving Target Detector (MTD) processing subsystem. - Except when the stand-by channel is in the maintenance mode, the stand-by channel MTD processing subsystem shall receive, process, and output all current data from the active channel. This will insure that data is available from both SP's for remoting. Automatic switching shall be provided to insure that data is outputted to the SCIP's provided the standby channel is not in maintenance and at least one transmitter/receiver and at least one MTD processing subsystem is operational. The automatic switching capability shall have a manual override.

3.12.1.2 Two-level weather contours.- Estimates of rainfall rate (rain reflectivity) shall be developed over 1 nmi range intervals by compensating for range in 1/16 nmi increments (difference between desired weather STC and actual STC) and determining whether programmed levels of rainfall rate have been exceeded in at least eight of the 16 range cells in the 1 nmi interval. Weather is detected in each range cell if the sum of eligible filter powers exceeds its programmed threshold. This detection shall be done for each CPI. Second time around weather shall be minimized by requiring a detection in each 1/2 nmi range position in the high PRF CPI and in either of the adjacent low PRF CPIs. Detections shall be output to the C&I weather process every CPI pair. Smoothing of the threshold-crossing data shall be effected in the correlation and interpolation processor for formatting and transmission to the weather data mode select unit. The estimates of rainfall rate thus derived, shall be accurate to within ± 3 dB (referred to nominal dBz value) for those range/azimuth cells in which the rain/fixed ground clutter ratio is equal to or greater than +10 dB. For those range/azimuth cells where a clear day map, described in paragraph 3.12.3.4.11, indicates the presence of fixed clutter, only the nonzero doppler filter outputs shall be used to reduce the ground clutter signals prior to contour smoothing. The error thus induced in estimating the rainfall rate in these cells shall be considered acceptable. Contours of two-levels of rainfall rate shall be developed and updated at intervals of six scans. Collection of all weather data shall be completed every six scans or less at the radar site and completely processed and transferred (all 30,720 cells) into the SCIP within three scans or less of completion of collection of weather data. When the SCIP parameters are chosen to minimize delay in the SCIP, the weather data of each range/azimuth cell shall be displayed no more than nine scans after the collection of the first sample of data in that cell and all surrounding cells used in the smoothing and contouring processes. When operating in the sector mode after the system has been running, the display of weather data at each range/azimuth cell shall be updated every seven scans or less.

<u>3.12.1.3 Range clock pulses</u>.- The range clock pulses in no case shall exceed 75 percent of the transmitted pulse width. The range clock pulses shall be used for the RAG, STC generator range information, and other applications. A spare isolated output with an output level to drive Transistor Transistor Logic (TTL) devices across 75 ohms shall be provided.

<u>3.12.2 System Timing Unit (STU)</u>.- The STU shall provide all timing signals necessary for operation of the radar system. It shall: provide for bursts of eight to ten-pulse transmissions at each of two Pulse Repetition Intervals (PRI); and, using ACP and ARP signals from the antenna, synchronize CPI's in order to support the creation of a synchronous clutter map using the zero-velocity filter, as specified in paragraph 3.12.3.4 which shall be used to measure the ground clutter amplitude in each range/CPI cell. The STU shall synchronize CPI's from scan-to-scan to insure that the center of each CPI is repeated to within .088 degrees for proper updating of a fixed ground clutter map. This STU shall also provide: modulation triggers to the transmitter; STC triggers to the receiver front end; display triggers to analog display; counted down beacon triggers; strobes to the I&Q A/D converters; all of the necessary data memory strobes to the DSP; and, shall provide the absolute ACP count for each CPI to the DSP. This unit shall also provide the same timing

signals to the system when the antenna is stopped for single range gate coherence measurements (Maintenance and Performance Monitoring Timing Signals, paragraph 3.12.2.7) and provide triggers to the system test target generator under manual or program control. The location of the STU is optional within each channel.

3.12.2.1 Pretrigger timing signals.- The timing of the following pulses shall be adjustable over the pretrigger period, defined as the time interval 100us prior to T_O, where T_O is the time at which the main RF pulse is transmitted.

(a) Beacon pretrigger pulse (PRF counted down shall be adjustable in a 16 ACP interval by changing PROMs)
(b) Display trigger pulse
(c) Two spare trigger pulses.

Beacon interrogation shall be synchronized to the primary radar transmission. During the 18-pulse CPI pair, seven interrogations shall occur; during the interval prior to the next CPI pair, an eighth and ninth interrogation may occur, depending on the number of radar fill pulses. Interval between interrogations shall not be less than the sum of the short and the long radar interpulse periods; average interrogation rate shall not exceed 450 Hz per 16 ACP interval. In order to insure against interference between the radar channels, the system timing for the standby channel, whether or not it is in the maintenance mode, shall be synchronized with that of the active channel which shall be the "master" timing source.

3.12.2.2 Radar Pulse Repetition Frequency (PRF).- The PRF of the radar sweeps shall be constant within a given CPI. Alternate CPI's shall have different PRFs in the ratio of at least 4:5. The maximum degradation at the first blind speed null shall not exceed 9 dB. A maintenance adjustment shall be provided to vary the basic set of PRFs by ± 5 percent in increments of one percent or less, while meeting all other requirements.

3.12.2.3 Time base.- The time base for the radar must be synchronous with that of the data acquisition system of the signal processor. Thus, both time bases must be derived from the same source. To reduce potential interference from IF leakage, this source shall be derived from, or locked to, the IF COHO. The accuracy of this time base shall be better than 10^{-5}.

3.12.2.4 Data acquisition control signals.- The data acquisition control signals shall consist of the following:

(a) The received signal A/D encode command pulses (the range gate sampling signal) specified in paragraph 3.12.2.3.

(b) Data gate signals to the signal processor to control the data memory input timing.

<u>3.12.2.5 Coherent Processing Interval (CPI) to azimuth synchronization</u>.- There shall be a minimum of 4,096 active interrogations per 360 degrees rotation of the antenna. The STU shall synchronize the alternate CPI's to a set of preselected antenna positions so that a coherent ground clutter map can be established. The synchronization timing error shall be less than .088 degrees. This synchronization shall be maintained over antenna speed variations caused by wind loading and by mechanical imperfections. The STU (paragraph 3.12.2) shall also provide passive horn switching signals to the RAG. Provisions shall be made for azimuth synchronization to eliminate second time around ground clutter at each CPI boundary.

<u>3.12.2.6 Digital Signal Processor (DSP) timing signals</u>.- The STU shall provide the DSP processor with the following signals:

(a) A signal (or signals) indicating the start and the end of a CPI. A CPI shall start with the beginning of the data acquisition period of the first sweep; it shall end with the end of the data acquisition period of the last sweep of that CPI.

(b) The antenna position information at the start (or end) of a CPI shall be derived from the ARP's and ACP's.

(c) The PRI (high or low) used for the current CPI.

<u>3.12.2.7 Maintenance and performance timing signals</u>.- The STU shall provide the following timing signals to the radar system test and monitoring equipment:

(a) A trigger signal for the maintenance oscilloscope. This signal shall precede all signals generated during a radar sweep.

(b) A scope trigger at the start of a CPI and a trigger at the start of a CPI pair.

(c) A trigger to the Test Target Generator (TTG).

(d) An SGP pulse for system testing. This pulse shall be generated once per radar sweep and its timing shall be easily selectable over the entire interpulse (sweep) period. It shall be in synchronism with an A/D encode pulse. The SGP test is usually performed with the antenna in a spotlight (stopped) position. In order to provide the alternate PRI bursts under this condition, the STU shall simulate ACP's and ARP's and provide them to other parts of the system such as the Test Target Generator (TTG). A manual mode control may be used for this condition.

<u>3.12.3 Digital Signal Processor (DSP)</u>.- The DSP shall receive and store eighteen samples of 24 bits each (I&Q) for each range gate during a CPI pair and shall process the sampled data received during the previous CPI pair. It shall use an input data memory to permit processing while receiving. The

processor shall test for A/D overload (saturation) and pulsed interference, and shall tag all data for each CPI (eight or ten pulse group) in which either saturation or interference (S/I) was detected. It shall perform digital filtering using eight or ten pulses for each range gate, and shall develop normalized output magnitudes for each of the filters. It shall develop and update a synchronous clutter map (paragraph 3.12.3.4.5) using the output of the Zero-Velocity Filter (ZVF) in an auxiliary memory unit. It shall perform adaptive Constant False Alarm Rate (CFAR) by developing mean-level-thresholds bracketing the gate of interest, for each of the nonzero velocity filters. It shall declare a primitive target detection by filter and by range when the threshold(s) for that cell(s) is exceeded. It shall compare the zero-velocity filter amplitude(s) with the clutter map for possible primitive target declaration during each CPI. This unit shall provide for the detection of two levels of rain in all filters over 1 nmi range intervals. This unit shall also provide for the detection of two levels of weather in all nonzero filters over 1 nmi range intervals. This detection process shall require that for each range cell in the 1 nmi interval, the sum of the filter powers in the allowed set shall be thresholded. The number of range cells exceeding a threshold must be at least 8 of the 16 cells in the 1 nmi interval for detection to occur for a given rainfall rate. This detection shall be done for each CPI. To minimize second time around weather detections, detections must occur each 1/2 nmi range position in the high PRF CPI and in either of the adjacent low PRF CPIs. Detections shall be output to the C&I weather process every CPI pair. The processor shall format messages indicating primitive target declarations and shall append range, azimuth, amplitude, velocity (filter number), which CPI (high frequency or low frequency) and status. The processor shall also format weather detection messages indicating the range at which either of two thresholds was exceeded. These data shall be transmitted to the correlation and interpolation unit for further processing.

3.12.3.1 Digital Signal Processor (DSP) inputs.- The inputs to the DSP shall be:

(a) In-phase (I) A/D interface output (12 bits)

(b) Quadrature-phase (Q) A/D interface output (12 bits)

(c) Input memory control strobes from the STU

(d) CPI-type strobe from the STU

(e) CPI azimuth centroid from the STU (12 bits)

(f) Range coverage gates, if required

(g) PRI for this CPI.

3.12.3.2 Digital Signal Processor (DSP) outputs.- The output of the Digital Signal Processor shall consist of primitive target reports for the CPI being processed. The primitive target reports shall contain the following information:

(a) Target range
(b) Target azimuth (12 bits)
(c) Filter number
(d) Target magnitude in dB (10 bits)
(e) PRI used
(f) Weather threshold crossing messages
(g) Digital Signal Processor Status

3.12.3.3 Major functions of the digital signal processor.- Major functions of the Digital Signal processor are as follows and shall be microprogrammable:

Saturation/Interference Test
Filters
Magnitude of filter outputs
Adaptive Thresholding
Clutter Map
Zero-Velocity Filter Thresholding
Combined Thresholding
Weather Processing
Threshold/Censoring Map

The detailed design requirements for the processor and for each of these functions are specified in the following paragraphs.

3.12.3.3.1 Digital Signal Processor (DSP) parameters.- The following parameters in the DSP shall be adjustable at the site:

(a) Mean level threshold-nonzero filters.
(b) (n) - Number of scans to update clutter map.
(c) Zero velocity threshold.
(d) Combined threshold.
(e) Interference test coefficient (K).
(f) Maximum number of ZVF primitives allowed in each CPI.
(g) Selection of the threshold to be used from 0 nmi to 13/16 nmi.
(h) Threshold/censoring map threshold levels, range, and azimuth location.
(i) Coarse clutter map range-azimuth selection.

3.12.3.4 Digital Signal Processor (DSP) performance requirements.-

3.12.3.4.1 Overall performance.- Returns from a group of eight to ten successive radar transmissions; i.e., a CPI, shall be stored and processed through a bank of at least eight digital filters. Each filter shall be designed to accept a band of doppler frequencies and to reject other doppler frequencies so as to enhance the detection of radar signals in clutter and weather background. The complex filter outputs shall be detected by means of a magnitude algorithm. Adaptive thresholds shall be generated for each filter. A target/no-target decision shall be made once per scan in each doppler resolution cell for every range cell in each CPI. Radar echoes which cross a threshold in any filter shall be declared a primitive target and shall be transmitted to the C&I processor as digital information consisting of range, azimuth, amplitude, and filter number of the threshold that was crossed. No truncation or round-off shall be permitted in the arithmetic manipulations, before the magnitude computation. The DSP functions will be subject to site-dependent parameter variations and shall be implemented in a modular form that can support additions and deletions to operating algorithms, without affecting code modules not being changed. In addition, 60 each, 1 nmi contiguous range cells shall be processed during alternate CPI's to determine if programmed levels of precipitation echo have been exceeded. The parameters of this processing unit, including filter coefficients, are to be programmable and selectable on a radar site dependent basis, and the proposed unit architecture shall provide this feature. The DSP, as described in paragraph 3.12.3 and as implemented in the functional units whose design requirements are specified in the following paragraphs, shall exhibit the following overall performance characteristics:

(a) MTI improvement factor - Shall be within 2 dB of that attainable with an optimum eight pulse processor for 40 dB clutter with a spectrum that corresponds to the antenna scanning modulation.

Note: MTI improvement factor is a power ratio defined as $I(f_d) = Y_o/Y_i$ where Y_o is the ratio of target power to interference residue power at the processor output; Y_i is the ratio of target power to interference power at the input to the processor and f_d is its target doppler offset frequency. The clutter spectrum is assumed to be centered at zero velocity.

(b) Dynamic range - The linear dynamic range of the system shall be determined by the number of bits in the analog-to-digital converter. No part of the processor shall restrict the linear dynamic range to values less than would be experienced if the system were completely linear with its dynamic range limited only by the A/D converters.

(c) False alarm rates - When the receiver signal channel is passing only thermal noise and the COHO channel is operating normally, the false threshold crossing rate of any doppler output shall not increase by more than a factor of two when the RMS noise level as measured at the A/D converters is decreased from 10 quanta to one quantum.

(d) Sensitivity - When the receiver channel is passing only thermal noise at a false alarm rate of 10^{-5}, the best obtainable sensitivity in each nonzero doppler filter, using an RF test target generator, shall be within 1 dB of the computed sensitivity. For this test, the test signal pulse may be centered on a range gate for minimum gate splitting loss and the doppler frequency may be centered in the passband of each doppler filter.

3.12.3.4.1.1 Data memory.- Memory capability shall be provided to store the digitized I&Q samples from all range gates for two interpulse periods (two CPI's). The data from the oldest CPI shall be processed while the data from the latest CPI is being stored.

3.12.3.4.2 Saturation/Interference (S/I) testing.-

3.12.3.4.2.1 Saturation level test.- If any of the I or Q video samples causes limiting to occur in the A/D's, all data from that range gate shall be voided for that CPI during the current antenna scan. Accordingly, any threshold crossings in that cell shall be tagged, and the contribution of that cell to the adaptive threshold (paragraph 3.12.3.4.4) shall be excluded from the threshold calculation. Tagged primitives shall be used by the C&I processor to prevent split reports on saturating targets but shall not initiate a report.

3.12.3.4.2.2 Interference test.- The quantity "T" where

$$T = K \sum_{j=1}^{8 \text{ to } 10} \left(\left| I(j) \right| + \left| Q(j) \right| \right)$$

shall be calculated and then the $\left| I \right| + \left| Q \right|$ for each input point compared with T, where K is a programmable constant (nominally set to 1/2). If T is exceeded by this value for any input point, it is presumed that it was the result of pulsed interference. Such a pulse would render all data from the gate suspect, and all threshold crossings from that range/CPI cell are to be inhibited for that scan. The adaptive threshold shall not contain contributions from that cell.

3.12.3.4.3 Filters.- The MTD shall have a minimum of eight doppler filters per CPI. The Digital Signal Processor shall be capable of being microprogrammed to process eight, eight pulse FIR doppler filters with a complete freedom in the selection of doppler filter coefficients of at least 11 bits plus sign without truncation to the magnitude. The contractor shall provide the capability for the processing of 10 radar transmissions in the short pulse repetition time CPI's and the processing of 8 radar transmissions in the long pulse repetition CPI's, and adaptive selection of two filter pair 1 characteristics each optimized for a different level of ground clutter under control of the clutter map. The cells of the filter select map shall be 2 CPI (one beamwidth) in azimuth by either 1/2 nm or 2 nm in range selectable at the RMS. The selection of filter pair 1 characteristics shall be based on the peak amplitude of the clutter map data within a map cell; the filters optimized for heavy ground clutter shall be employed during the bordering CPI pairs as well as the CPI pair within the map cell where the strong echoes occur. The decision threshold shall be adjustable in 1.5 dB increments between 35 and 60 dB above RMS noise level. The contractor, by using 10 pulses at the short interpulse period and 8 pulses at the longer period which provides identical duration for the two CPI's, shall provide the capability for allowing bandwidths and spacing of the two-filter sets to match in doppler rather than in doppler/PRF. The contractor shall provide the capability for a pair of zero doppler filters to reduce the azimuth sampling loss.

<u>3.12.3.4.3.1 Recommended filter characteristics</u>.- A set of filters compatible with all affected specified performance shall be provided by the contractor. The filters shall be programmable by substitution of a PROM; the contractor shall not be responsible for degradation of performance caused by substitution of alternate filters. Table I defines a recommended set of 18 filters for a CPI pair, that provides low doppler sidelobes to enhance target detection in weather. The alternate filter pair 1, automatically chosen in mountain clutter regions, maintains the same center frequency (line 1 of table 1) to preserve good detectability over clutter when the aircraft is near the critical first dim speed (approximately 120 knots). It sacrifices some of its ability to suppress rain clutter in the doppler sidelobes (line 5 of table 1) to improve its capability of rejecting ground clutter (line 6 of table 1). Filter weighting coefficients shall be chosen to produce the same noise gain in all filters and a log output from all filters close to but less than the maximum 10-bit value when the input I and Q data are maximum values (with doppler optimum for an individual filter).

<u>3.12.3.4.3.2 Magnitude of filter outputs</u>.- The sum of the real and imaginary filter output powers shall be calculated and shall be retained in a 10-bit LOG_2 format (LSB=3/32dB). All approximations used in this calculation and in the adaptive threshold calculation (paragraph 3.12.3.4.4) shall not degrade sensitivity by more than 0.3dB, when RMS noise is between 1 and 5 LSB's at the A/D converter.

<u>3.12.3.4.4 Adaptive thresholding</u>.- For each nonzero filter, a threshold shall be utilized which is the greater of the thresholds calculated using a set of echo samples at a shorter range and a set of echo samples at longer range than the cell of interest. In the absence of S/I, each threshold calculated shall be based on the total power in nine samples within the range interval 1/8 to 13/16 nmi from the cell of interest (12 possible locations). The following shall be excluded from the power sum:

1. Samples with S/I indications.
2. The sample without S/I having the largest amplitude and two adjacent samples.

The shorter or longer range mean-level-threshold (MLT) for the cell of interest shall be computed by adding to the power sum (in dB) a value

TABLE I FILTER CHARACTERISTICS

Characteristic	PRF	FILTER *0	FILTER *1	FILTER *2	FILTER *3	FILTER *4	FILTER *1A
1. Center Frequency Average PRF	High	*0.08	*0.24	*0.33	*0.42	*0.51	*0.24
	Low	*0.09	*0.24	*0.32	*0.40	--	*0.24
2. Bandwidth (3 dB) Average PRF	High	0.15	0.15	0.15	0.15	0.15	0.12
	Low	0.14	0.14	0.14	0.14	--	0.13
3. Bandwidth (10 dB) Average PRF	High	0.25	0.25	0.26	0.24	0.24	0.22
	Low	0.25	0.25	0.25	0.25	--	0.22
4. Bandwidth (20 dB) Average PRF	High	0.34	0.33	0.34	0.34	0.34	0.29
	Low	0.33	0.33	0.33	0.33	--	0.29
5. Max. Sidelobe (dB Below Peak)	High	41	39	41	41	41	25
	Low	41	40	40	40	--	26
6. Clutter-To-Noise Attenuation (dB) (beamwidth= 1.4 degrees, RPM=12.5)	High	--	44.3	55.4	57.4	56.3	51.8
	Low	--	45.4	59.7	55.9	--	52.3

*All filters are mirror image pairs:
Filter +N has maximum response at the designated positive doppler.
Filter -N at the designated negative doppler.
Filter ±1A is substituted for filter ±1 in mountain clutter regions.

dependent upon the number of cells contributing to the sum (9 max.) and the desired Probability of False Alarm (PFA). This table of values shall provide choice of PFA between 10^{-4} and 10^{-6} in 3/32 dB threshold increments. The MLT for any range gate and any filter shall be equal to or greater than the peak quantization noise of the system. If a filter output exceeds the computed threshold value it shall be subjected to the additional thresholding checks described in paragraph 3.12.3.4.8.

<u>3.12.3.4.4.1 .Adaptive thresholding for 0 nm to 13/16 nm range gates</u>.- The estimates of ground clutter amplitude and scanning modulation residue in each range/azimuth/filter cell, in the range interval 0 nm to 13/16 nm shall be kept in mass storage known as a residue map. The residue map shall be generated for each filter using the same techniques as the ground clutter maps (paragraph 3.12.3.4.5). Adaptive "mean-level-threshold" (MLT) levels shall be developed for the range between 0 nmi and 13/16 nmi by using the sum generated by the leading set of cells only as described in paragraph 3.12.3.4.4. The selection of the threshold shall be a site selectable parameter.

<u>3.12.3.4.5 Clutter map</u>.- The estimates of ground clutter amplitude in each range/azimuth cell shall be kept in mass storage known as a clutter map in LOG_2 format. The map shall be synchronous (a given clutter cell must continually reflect the clutter from the same area in both range and azimuth) and shall have a range resolution of one range cell and an azimuth resolution of one CPI. Prior to use of the value from the map for thresholding during the current scan, it shall be updated by adding 7/8 of the present map voltage to 1/8 of the present scan voltage and restored for use during the next scan. An ability to restrict the updating of the clutter map to any 2^nth scan ($n \leq 4$) shall be provided. If transmission is interrupted or if interference has been detected, the map shall not be changed. On powering-up the clutter map shall be set 6, 12, or 18 dB (adjustable) above the echoes received during the first scan and the declaration of zero-velocity target reports shall be suppressed for that time. When switching polarization, present map values shall be boosted 6, 12, 18, or 24 dB; the boost shall be selectable and shall be dependent on the new polarization.

<u>3.12.3.4.6 Zero-Velocity Filter (ZVF) thresholding</u>.- In order to threshold the ZVF output(s), it is necessary to use the clutter map which contains cells for each range-azimuth resolution cell of the radar. The cell values shall be represented as 8-bit LOG numbers (minimum) capable of representing signals up to the full dynamic range of the system. Each zero-velocity filter output is compared to the sums of the corresponding clutter map value and two offset factors (all in dB). The lower offset factor shall be adjustable to obtain primitive PFA's from the pair of zero-velocity filters which range from 10^{-4} to 10^{-6} in increments of 3/32 dB. The differential between the two thresholds shall be selectable in increments of 3/8 dB or less between 0 and greater than 11 dB. When the ZVF output exceeds the higher threshold, the primitive data sent to C&I shall be tagged.

3.12.3.4.7 Zero-Velocity Filter (ZVF) overload limiting.- Since the clutter map values are temporally smoothed over a minimum of 8 scans, excessive numbers of zero-velocity primitive declaration can occur with the onset of interference. To prevent overloading subsequent processing, the rate of zero-velocity primitive declarations per CPI shall be limited to fewer than Z. If more than Z ($32 \geq Z \geq 8$) zero-velocity primitives are declared during a CPI, then all zero-velocity primitive reports shall be erased and none transmitted to subsequent processing stages.

3.12.3.4.8 Combined thresholding.- In areas where combined thresholding is designated, all nonzero primitive target magnitudes (paragraph 3.12.3.4.4) shall be compared to a combined threshold which is the power sum of the adaptive threshold-MLT and a fraction of the zero-velocity filter power for the same range cell. If the filter output power is equal to or greater than the combined threshold, a primitive report shall be generated.

Antenna scanning modulation residue in the presence of limiting ground clutter introduces noise into the nonzero-velocity filters, at levels equal to or greater than system noise, and can increase the rate of correlated false alarms. Combined thresholding shall be used to desensitize those range/CPI/filter cells containing "very high" clutter power. The amount of desensitization (fraction of the zero-velocity filter power that is used) shall be separately adjustable for each filter. The range shall be -24 dB to -60 dB in 3 dB steps.

When the zero-velocity filter magnitude is below a programmable value (adjustable for each filter in 1 dB steps from 30 dB to 60 dB) for the range/CPI/filter cell under test, the zero-velocity filter contribution to the threshold is set to zero and the MLT for this cell shall be used.

In order to prevent the combined threshold from being activated by precipitation in all geographical areas, the use of the combined threshold is to be restricted by two independently selectable isolated windows. Both windows shall have independently selectable (programmable) start/stop range and azimuth. The range start/stop shall be selectable in increments of 2 nmi or less, and azimuth start/stop in increments of 1 CPI pair.

3.12.3.4.8.1 Combined thresholding 0 Nautical Miles (nms) to 13/16 Nautical Mile (nm).- Gates in the range 0 nm to 13/16 nm shall be thresholded using residue-map cell values as determined in paragraph 3.12.3.4.4.1, if selected or if nonzero filter CFAR is selected the combined threshold shall be available.

3.12.3.4.9.- Not used.

3.12.3.4.10.- Not used.

3.12.3.4.11 Weather processing module.- This unit shall be designed to detect the presence of precipitation clutter which exceeds two normalized programmable amplitude levels in either linear polarization or circular polarization. The unit shall detect threshold crossings in range/CPI cells by thresholding the number of range cells exceeding the appropriate value of range dependent stored values (paragraph 3.12.1.2). These tables shall compensate for the system STC curves for both the main and passive receive paths and shall adapt to the range/azimuth gating between the two paths. The tables shall be computed by the contractor and stored in the weather processing module. Two tables shall be used when the system is operated in linear polarization, and two shall be used when the system is operated in circular polarization. The table values used (LP or CP) shall be selected automatically when the antenna polarization is selected. The values used for CP shall be 12 dB less than the LP values (or the minimum value necessary to control false alarms from noise, whichever is greater). On alternate scans of the antenna, and during each CPI, the system shall compare the sum of echo powers in the multiple filters at each 1/16 nmi to the range-dependent stored value. Individual site-dependent clear day maps shall be provided for each level (coarse 1 nmi resolution) to designate that data from filter pair 0 be omitted from the sum in clutter areas. The sums on the two CPI's shall be compensated to produce the same mean gain to noise. The contractor shall provide the means to generate the site-dependent stored maps in a time period not to exceed 8 hours. If the number of range cells exceeding the stored value in a 1 nmi range interval in the high PRF CPI is at least eight, then a detection is declared. To minimize second-time-around weather detection, the number must also exceed eight in either adjacent CPI (low PRF) at the same range. This process shall be accomplished in 1/2 nmi range increments for additional smoothing. Detections shall be output to the C&I processor for the high PRF CPI every CPI pair. This shall be repeated on the subsequent scan of the antenna for the other level of rainfall rate. These data shall be transferred to the C&I processor for temporal filtering, screening of false isolated threshold crossings, and for estimating contour intervals for both levels.

3.12.3.4.12 Thresholding/censoring map.- The threshold/censoring map shall be a site dependent thresholding/censoring screen to eliminate persistent correlated false alarms produced by moving ground traffic, and regions of limiting ground clutter. It shall contain a map of range/CPI cells with resolution of 1/8 nmi by 2 CPI's. The range and azimuth of each input primitive target report shall be used to look up a 3-bit number in the map. The 3-bit code from the map and the primitive target report maximum amplitude filter number shall be used (via a decoding table) to determine a threshold value for the primitive target. This thresholding is intended to implement a thresholding map with three values of flat (in doppler) thresholds and four values with a doppler shape the same as the antenna modulation clutter residues. These thresholds shall be provided by a look-up table indexed by filter number, map value, and PRF. The thresholds shall be adjustable from noise level to maximum filter output in steps no greater than 3/8 dB and will be compared with the magnitude of the highest doppler threshold crossing in a 1/8 nmi and two CPI cell. Provision shall be included to select thresholds for the 10-pulse CPI 1 dB higher than for the 8 pulse CPI to compensate for the greater number of pulses coherently integrated. This function shall serve as a geographic censor and selective microprogrammable range/azimuth attenuator. Primitive target reports that fail to pass the shaped doppler thresholds or flat doppler thresholds shall be eliminated. Primitive targets that pass the flat doppler thresholds shall be flagged as possible moving ground traffic target reports and passed on. The primitives which have passed the shaped threshold requirements shall be flagged also for further identification for track initiation purposes. Primitive target reports from RTQC targets and MTI reflectors (detected by range and azimuth) shall be flagged to provide separate processing of these special targets. Processing of these special targets shall be normal except that they shall neither affect the thresholding or be affected by the thresholding specified in paragraphs 3.12.4.3.6 and 3.12.4.3.7. The MTI reflector flag shall be carried to the SP to prevent track initiation and to designate the report as correlated. Radar reports from MTI reflectors shall not merge with beacon reports. Radar RTQC reports shall merge only with the beacon RTQC reports. These RTQC and MTI reflector radar reports, when transmitted to the Mode S System, shall be flagged.

3.12.4 Correlation and Interpolation (C&I) processor.- The C&I processor shall receive primitive target reports and weather contour data from the digital signal processor. Its principal function shall be to correlate; i.e., cluster, primitive target reports which are associated with a single, moving, aircraft target, and interpolate (estimate) the most likely range, azimuth, velocity, and magnitude. As the antenna scans by moving aircraft targets, a number of primitive target reports may be declared during each CPI and the target may be above threshold for as many as eight CPI's. Thus, large numbers of primitive target reports may be associated with a single moving target. The C&I processor shall develop a single target report for each separable cluster of primitive reports, and provide an estimate of range to within 1/32 nmi, azimuth to within 1 ACP, doppler on each PRF to within PRF/64, and the largest normalized amplitude to within 3/32 dB. Normalized amplitude is primitive amplitude minus peak signal-to-noise gain of the filter in which the primitive detection occurred. The target report shall also include the number of primitive target declarations associated with the report. The unit shall be microprogrammable and shall have certain parameters selectable for each radar site. It shall develop adaptive magnitude thresholds (paragraph 3.12.4.3.6) to prevent system overload under conditions of severe "angel" activity. This unit shall format radar target reports for transmission to the surveillance processor and to a collocated radar beacon correlator (Mode S).

3.12.4.1 Correlation and Interpolation (C&I) processor inputs and outputs.- The inputs to the C&I processor shall be primitive radar target reports and weather information. The output of the C&I processor shall consist of centroided radar target reports, outputs within 0.14 sec of passing the target boresight position, and two-level weather contours. At a minimum, the C&I output shall contain the following information to the listed interfaces:

a. Dual sets of isolated outputs to colocated Mode S Processor.

1. Target range
2. Target azimuth
3. Maximum amplitude filter number PRF-1
4. Maximum amplitude filter number PRF-2
5. Interpolated velocity PRF-1
6. Interpolated velocity PRF-2
7. Amplitude
8. Report quality
9. Confidence
10. Selected ASR-9 channel status
11. Radar Real Time Quality Control (RTQC) targets (identifiable) including above information of items 1 through 9 for each RTQC target.
12. Tracking eligibility

b. To weather channel Mode Select Unit

1. Two level weather range/CPI contour point reports
2. Two level weather status

c. To SP

1. Same data as (a) above

d. To Remote Monitoring Subsystem

1. Real-time monitoring data as outlined in paragraph 3.12.4.3.9.

3.12.4.2 Major functions of the C&I processor.- The major functions of the C&I processor are as follows and shall be microprogrammable:

Input Data/Processing
Correlating of primitive reports
Interpolating target reports
Second adaptive magnitude censoring
Target load/false alarm control and final threshold
Final confidence selection
Two-level weather smoothing and contouring
Real-time monitoring
Output formatting

The detail design requirements for each of these functions are specified in the following paragraphs:

3.12.4.2.1 C&I parameters.- The following parameters in C&I shall be adjustable at the site:

(a) Not used.

(b) n - elimination of RFI false alarms.

(c) G - elimination of RFI false alarms.

(d) All parameters listed in Paragraph 3.12.4.3.5, 3.12.4.3.4, 3.12.4.3.6, 3.12.4.3.7.1, and 3.12.4.3.7.

3.12.4.3 Correlation and Interpolation (C&I) processor performance requirements.-

3.12.4.3.1 Input data processing.- Input data processing shall receive data in suitable format from the DSP over a high-speed I/O channel.

3.12.4.3.2.- Not used.

3.12.4.3.3.- Not used.

3.12.4.3.4 Correlating of primitive reports.- The contractor shall provide a clustering algorithm to correlate primitive target reports which are associated with the same moving target. This algorithm shall provide the following capability.

(1) Target report splits shall not exceed 1 percent of all target reports.

(2) Range and azimuth accuracy as specified by paragraphs 3.4.3.3.1 and 3.4.3.3.2 shall be met or exceeded.

(3) Resolution requirements as specified by paragraphs 4.3.6, 4.3.7, and 4.3.8 shall be met or exceeded.

Clustered reports which include primitives that have successfully passed the flat and shaped doppler threshold shall be flagged as such.

3.12.4.3.4.1 Elimination of Radio Frequency Interference (RFI) false alarms.- This function shall eliminate single CPI targets with n (where n is less than or equal to 10 and greater than or equal to 5) different doppler filter responses. In addition, if doppler filter design provides a different number of doppler filters at high PRF as compared to the low PRF, the above algorithm shall be implemented for both PRFs such that different n values shall be available for each PRF. Pulsed RFI occurring in a range gate containing large clutter/noise signals may not be detected by the interference test paragraph 3.12.3.4.2.2, and it shall be the function of this module to eliminate those clusters which are detected by this test. A means shall be provided to disable this feature.

3.12.4.3.4.2 Supplemental elimination of Radio Frequency Interference (RFI) false alarm.- If the number of single CPI reports G, counted in each 5 degrees sector in each scan is greater than or equal to 10 and less than or equal to

100, an interference condition shall be declared for this wedge for this scan. When an interference condition is declared all single CPI reports in this wedge shall be tagged as confidence level 010 reports and shall not initiate tracks this scan. When an interference condition is declared, all single CPI reports in this sector shall not update the second adaptive magnitude censoring. A means to disable this function shall be provided.

3.12.4.3.5 Interpolating target reports.- This function shall develop estimates of the centroids of clusters of primitive target reports, in range to within (1/32 nmi), azimuth to within (0.088 degree) and velocity in each PRF to within (1/64 of unambiguous interval). The contractor shall provide centroiding algorithms that meet or exceed the accuracy and resolution requirements of paragraphs 3.4.3.3.1, 3.4.3.3.2, 4.3.6, 4.3.7, and 4.3.8. It will be necessary to adjust some primitive report azimuth values for the case in which a cluster straddles zero degrees azimuth, in order to produce valid centroid. Correlated target reports (paragraph 3.12.4.3.4) containing zero filter and nonzero filter responses shall not be centroided in azimuth using information from the zero filter responses as long as there is at least one other primitive response from some other doppler filter in at least two CPI's.

The interpolating and target reporting unit shall append a "quality" factor to each centroid target report indicating the following:

(a)	One CPI report	00
(b)	Two CPI reports of different types (both PRF's)	01
(c)	Two or more CPI reports, same PRF	10
(d)	Three or more CPI's and both PRF's	11

At this point at least five target confidence indicators shall be added to the centroided target report. The confidence field shall consist of 3 bits. The first confidence indicator (000) will indicate that this target report is the centroid of a cluster with a moving ground traffic flag set (cluster which has successfully passed the flat doppler thresholds in the thresholding/sensor map). The second confidence indicator (001) indicates that this target report is the centroid of a cluster which has successfully passed the shaped doppler threshold and has not correlated with any unflagged primitives. The third confidence indicator (010) indicates that this target report (single CPI report only) is the centroid of a cluster from a 5 degrees sector in which interference has been declared.

The fourth confidence indicator (011) indicates that this target report is the centroid of a cluster in which no flags were set. The fifth confidence indicator (100) indicates that the maximum doppler threshold crossing in the target report is from the zero filter.

Confidence 000 - target reports from roads.
Confidence 001 - target reports from heavy clutter.
Confidence 010 - single CPI reports from interference.

Confidence 011 - target reports from aircraft, thermal false alarms, angels, etc., and range less than "R."
Confidence 100 - target reports whose maximum doppler response is from the zero filter.
Confidence 101 - target reports from aircraft, thermal false alarms, angels, etc., and range greater than "R."

All target reports beyond 40 nmi and RTQC targets shall be formatted and passed on to tracking eligibility (paragraph 3.12.4.3.7.1). The following target reports with confidence levels 000 through 101 (the selection of target reports by confidence level, quality, and range (2 zones) shall be considered as parameters) shall tentatively be formatted and passed on to tracking eligibility (paragraph 3.12.4.3.7.1).

(a) All target reports whose maximum doppler response comes from the zero filter (confidence level 100) with a quality of two or more.

(b) All target reports with a quality of two or more inside "R" where R is equal to or greater than 4 nmi and less than or equal to 32 nmi.

(c) All target reports (except target reports from the zero filter) with a quality of one or higher beyond "R."

(d) Target reports whose maximum response is from doppler filters ± 1 or ± 2 with quality 1 with confidence level 011 inside of range "R" and at least two doppler filter responses at each PRF shall be tested for similar interpolated doppler at each PRF. If the two measurements of doppler/average PRF differ by more than "ID" where "ID"is a parameter selectable between 0 and 1 in increments of 1/64, the target report shall be passed on to tracking eligibility.

All other target reports shall be formatted and passed on to second adaptive magnitude censoring (paragraph 3.12.4.3.6). Appended to each target report sent to second adaptive magnitude censoring shall be either (site selectable parameter) the maximum doppler magnitude of all doppler responses which make up the target report or the maximum doppler magnitude from each doppler filter. A switch shall be provided for system maintenance for all radar reports to bypass second adaptive magnitude censoring and target load/false alarm control and final threshold.

3.12.4.3.6 Second adaptive magnitudes censoring.- The primitive magnitudes (10 bits long) shall be corrected to account for differences in signal-to-noise gains of filters associated with an individual doppler group and shall be compared to an adaptive (load/false alarm controller and final threshold, paragraph 3.12.4.3.7) magnitude threshold by range, azimuth, and doppler filter. Target reports with corrected magnitudes below this threshold, for all respective filters (if selected in paragraph 3.12.4.3.5) shall be discarded. Target reports with at least one corrected magnitude above threshold shall be passed on to the target load/false alarm control and final threshold. Target reports which are passed shall include at a minimum the following information: centroided range, centroided azimuth, corrected magnitude and doppler filter number of all primitive threshold crossings which have successfully passed the second adaptive magnitudes censoring.

3.12.4.3.7 Target load/false alarm control, and final threshold.- This function shall develop adaptive threshold levels from target reports which pass second adaptive magnitude censoring to control the number of false alarms to the surveillance processor, ATC computers, and Mode S. False alarm control shall be implemented in the following manner:

Target report magnitudes shall be compared against thresholds in 1809 cells in range, azimuth, and doppler filter occupying the first 39 nmi of radar coverage. The number of range, azimuth, and doppler cells shall be expandable to 48 nmi of radar coverage (2673 cells). The cells shall be developed as follows: nine Doppler filter groups (-3, -2, -1, -0, +0, +1, +2, +3, ±4).

Range Bins	Azimuth Bins
0 to 1 nmi (adjustable to cover the airport surface area)	1
1 to 7 nmi	8
7 to 13 nmi	16
13 to 17 nmi	16
17 to 23 nmi	32
23 to 28 nmi	32
28 to 32 nmi	32
32 to 36 nmi	32
36 to 39 nmi	32
39 to 42 nmi	32
42 to 45 nmi	32
45 to 48 nmi	32

Any target report which does not bypass second adaptive magnitude censoring (paragraph 3.12.4.3.6) is compared to two thresholds. The first threshold occurs in second adaptive magnitude censoring (paragraph 3.12.4.3.6) and upon successful completion the target report is subjected to a final threshold in target load/false alarm control. Each threshold level generated is based upon the number and magnitude (strength of target) of weak target reports occurring in each of the 1809 cells.

The chain of events occurring in second adaptive magnitude censoring and target load/false alarm control, and final threshold starting from time zero or immediately following the updating of threshold THR in adaptive magnitude censoring are as follows:

For each primitive threshold crossing (if selected in paragraph 3.12.4.3.5) of each target report successfully passing the threshold THR, THR shall be increased by THI (a parameter adjustable in 3/32 increments between 3/32 and 1.5 dB) and in addition a counter value CO (previously set to zero during THR updating) shall be increased by one. The threshold in second adaptive magnitude censoring is THR and shall be incremented by THI before the next target magnitude is compared to THR. Both the threshold THR and counter value CO shall be incremented only in the cell corresponding to the doppler filter, range, and azimuth of primitive doppler threshold crossing. The THR and CO values of the zero-velocity filter pair shall be incremented only if the ZVF primitive magnitude is above the two threshold levels defined in paragraph 3.12.3.4.6 (a tag). The target report which just incremented the threshold (as discussed above) is subjected to a final threshold before passing on tracking eligibility. The final threshold (FTHR) is equal to a constant (Z) (adjustable from 0 to 6 dB in 3/32 dB increments) added to THR. Each primitive threshold crossing of target report shall be compared to FTHR and if all magnitudes are below FTHR the target report shall be discarded. Target reports with at least one magnitude above the threshold shall be passed on to the tracking eligibility. At the end of NScan where NScan is adjustable between 1 and 25, interval threshold THR shall be updated according to the following rules:

a. If the value of CO is less than CO1 (CO the number of weak targets occurring in NScan), where CO1 is adjustable between 0 and 16, then THR = THR - DEC1.

b. If the value of CO is equal to or greater than CO1 and CO is less than CO2 where CO2 is adjustable between 2 and 32, then THR = THR - DEC2.

c. If the value of CO is greater than or equal to CO2 then THR = THR - DEC3.

DEC1, DEC2, and DEC3 shall be adjustable in 3/32 dB increments between 0 and 6 dB.

Following the updating of THR the value of CO is set to zero and the cycle starts over. Not all cells need to be updated on the same scan, and this processing load can be distributed in time (over NScan). Two maximum thresholds MAX 1 and MAX 2 for each of the 11 range segments shall limit THR from +2 dB to +30 dB (select all in 2 dB steps) referred to system RMS noise.

MAX 1 will limit the value of THR in the zero filter and MAX 2 in the nonzero filters.

3.12.4.3.7.1 Tracking eligibility.- Two additional tracking eligibility indicators shall be added to the target reports at this time for the purpose of indicating to the SP, Mode S, or the ATC tracker which target reports should be allowed to update a track or to start a new track. Target reports that are considered eligible for track initiation (track initiation eligible) shall be allowed to update tracks and to start new tracks. Target reports that are considered eligible for track correlation (track correlation eligible) shall be allowed to update tracks only. The selection of target reports by confidence level, quality, and range. (inside and beyond range "R") for track initiation eligibility and track correlation eligibility selection shall be a parameter.

The following target reports shall tentatively be considered as track initiation eligible:

a. Confidence level 000 reports with a quality of two or more.
b. Confidence level 001 reports with a quality of two or more.
c. Confidence level 011 reports with a quality of one or more inside of range "R" and all reports beyond range "R".
d. Confidence level 100 reports with a quality of three.

All the remaining target reports with the possible exception of confidence level 000 reports will be considered track correlation eligible.

3.12.4.3.8 Two-level weather smoothing and contouring.- The weather data smoothing and contouring unit shall receive a single stream of range ordered threshold crossings for two levels of weather from the MTD processor reported consecutively. This shall be accomplished for each of the two weather levels using alternate scans. Smoothing of the data to eliminate long-pulse interference and isolated zeroes from continuous streams of threshold crossings shall be effected as described in the following subparagraphs. At six scan intervals, a two-level contour map shall be transferred to the outputting unit for transfer to the receive only weather channel mode select unit (3.21.15), for subsequent output to the SCIP.

3.12.4.3.8.1 Temporal smoothing.- This function shall develop two weather maps with 1/2 nmi range granularity and 1.4 degrees azimuth granularity, representing the median weather level detected during 3 pairs of scans, (a detection on 2 of 3 pairs of scans). A pair consists of alternate scans using heavy and light weather thresholds.

3.12.4.3.8.2 Spatial smoothing.- This function shall develop two weather maps with 1/2 nmi range granularity and 1.4 degrees azimuth granularity defining the level of weather equalled or exceeded in WWW (parameter) of 9 cells of the temporally smoothed data (3.12.4.3.8.1), each cell and its eight neighbors. Where the number of input data cells is less than 9, WWW shall be scaled proportionately (to the closest integer value).

3.12.4.3.8.3 Contouring.- This function shall develop and report a single weather map with 1/2 nmi range granularity and 1.4 degrees azimuth granularity defining the highest level of weather detected in 3.12.4.3.8.2 in each 9 cell cluster (each cell and its 8 neighbors). The two-level weather detection system capacity shall provide smoothing and contouring in all weather cells (approximately 30,720) every six scans.

3.12.4.3.9 Real-time monitoring.- This function shall monitor the status of real-time data within the C&I processor. It shall accumulate, scale, format, and output data on a per scan basis for display on the system status monitor. These data shall include, but not be limited to, the following reports during each scan of the antenna:

(a) Primitive target reports - total

(b) Primitive target reports - each filter

(c) Output target reports - total

(d) Number of output target reports by quality, confidence, and range bins (for each of the first 9 range bins described in paragraph 3.12.4.3.7 and for targets beyond 39 nmi).

(e) Indication of interference declaration on last scan (paragraph 3.12.4.3.4.2).

(f) Value of all second adaptive magnitude censoring (updated at a minimum of every 75 scans).

(g) Value of any one selected second adaptive magnitude censored cell on scan to scan basis.

(h) Two level weather status.

(i) Number of weather reports from DSP for each level of weather.

(j) Number of output weather reports for each weather level.

(k) Not used.

(l) Weather map (paragraph 3.12.4.3.8).

3.12.4.3.10 Output formatting.- This function shall receive data from C&I and shall format these data for transmission to the SP. Dual sets of isolated outputs shall be provided for future use with Mode S, as described in appendix III. However, the C&I output and the SP input format shall be under firmware control (paragraph 3.4.4.1) to provide the ability to reformat messages to any message length, word length, and/or bit assignment.

3.12.5 Surveillance Processor (SP).- The SP shall receive beacon target video from the ATCBI receiver along with radar target reports from the C&I processor. The SP shall perform the functions necessary to convert the beacon video pulse train from each aircraft to a single digital target message. The resultant beacon target shall then be compared with the C&I radar target reports so that messages with coincident range and azimuth positions shall be forwarded to the remote site as a single beacon target with a radar reinforced bit set in the message. C&I targets which have been merged with a beacon report shall be flagged as such and all flagged and unflagged targets shall be forwarded to the radar report-to-track correlation function. Flagged C&I target reports shall not be disseminated to the remote facility. It shall also be the function of the SP to use scan-to-scan target history to identify correlated C&I aircraft target reports (within three to five scans) while flagging or eliminating (selectable) those false target reports which are not associated with moving aircraft targets. The SP shall output fewer than 1.0 false scan correlated radar target reports per scan averaged over a 1 hour period, during normal operating conditions. The peak rate of display of false scan correlated radar targets shall be fewer than ten per scan averaged over one hour, under extreme conditions of "angel" activity or ducting. The following features shall be incorporated into each ASR-9 processing and system configuration for use with the Mode S system.

(a) SP shall provide dual sets of isolated inputs for Mode S data (paragraph 3.12.5.1(b) radar reports, beacon reports, merged reports, etc.). The SP shall select automatically the Mode S input to be processed.

(b) As part of the Mode S to SP interface a signal shall be provided by Mode S to indicate the channel on-line status of Mode S system. When the Mode S system has been installed and operating properly, this signal shall disable the following functions of the ASR-9.

    (1) C&I input to the SP
    (2) beacon target detector
    (3) the radar and beacon merge function output to the scan-to-scan correlator

    If the Mode S status signal indicates that Mode S system is not on-line, the above mentioned disabled ASR-9 functions shall be restored automatically.

(c) The beacon target detector (part of the SP) will receive and process beacon video from the Mode S system in the event of Mode S processing failure.

(d) The ASR-9 will provide dual sets of isolated outputs to provide C&I data to Mode S as described in paragraph 3.12.4.1.

(e) Mode S system will merge Mode S beacon reports and radar reports from C&I.

(f) Upon completion of the merge function, Mode S will send the following information to the SP with a minimum time delay of .34 seconds and maximum time delay of .5 seconds as compared to antenna boresight.

(1) radar only reports
(2) beacon only reports
(3) merged radar and beacon report
(4) Mode S/ASR-9 status

(g) The SP shall transmit the information described in paragraph 3.12.5.(f) to the ATC computer with a maximum delay of .78 seconds measured at the ATC computer as compared to antenna boresight. The scan-to-scan correlator (part of the SP) shall process the data from Mode S as described in paragraph 3.12.5.6. The maximum delay of the scan-to-scan correlated radar reports for ATC display shall not exceed 2.1 seconds as compared to antenna boresight. The Mode S to ASR-9 interface is fully described in appendix III.

(h) A clock shall be provided to the ASR-9 with a precision of 1/128 of a second. The clock shall be used to determine time in storage of each target transmitted to the SCIP. Time in storage will identify the time interval between the centroided target position and the time of transmission into the modems. The time in storage calculation shall be determined to an accuracy of 1/128 of a second with the most significant bit representing a minimum of 1 second. Only the five most significant bits need to be sent to the SCIP. Time in storage shall be calculated as follows:

Time in storage = time the target is transmitted into the modems minus time of occurrence of the sector mark before the centroided position of the target minus [centroided target azimuth (in ACP's) - sector mark azimuth (in ACP's) before the centroided position of the target] multiplied by the time of 1 ACP at the nominal scan rate. The transmission of time to the Mode S is not required.

This processor unit shall format and transmit beacon reports, and radar target reports to the remote site and output data to the maintenance display to support on-line performance monitoring functions.

<u>3.12.5.1 Surveillance Processor (SP) inputs</u>.- As a minimum, the inputs to the SP shall be:

(a) ASR-9 inputs:

(1) Beacon video and mode triggers
(2) C&I radar target reports

(3) Antenna azimuth data
(4) Status

(b) Mode S inputs when fully operational:

(1) Uncorrelated C&I radar target reports that have not merged with Mode S beacon reports
(2) Mode S beacon reports
(3) Mode S/Radar reinforced reports
(4) ASR-9/Mode S status
(5) Mode S channel on-line signal

(c) Mode S input when Mode S processing fails

(1) Mode S beacon video and mode triggers

3.12.5.2 Surveillance Processor (SP) outputs.- As a minimum, the outputs of the SP shall be:

(a) Beacon only reports
(b) Beacon/radar reinforced reports
(c) Correlated radar target track reports
(d) Uncorrelated C&I radar target reports that have not merged with beacon reports
(e) Performance monitoring data (including the number of reports associated with items (a) through (d) above)
(f) Azimuth sync message

3.12.5.3 Major processing steps of the Surveillance Processor (SP).- The major processing steps of the SP shall be:

(a) Beacon target detection
(b) Beacon/radar target merge
(c) Primary radar target report-to-track association
(d) Resolution of target report-to-track association conflicts
(e) Formatting and output of beacon only reports, radar only reports, merged radar and beacon reports, and correlated radar only reports
(f) Track updating and prediction
(g) Track initiation using radar reports not associated with existing track files

3.12.5.4 Surveillance Processor (SP) implementation.- The surveillance processing function will be subject to site-dependent parameter variations and shall be implemented in a modular form that can support additions and deletions to operating algorithms, without affecting code modules not being changed.

3.12.5.5 Beacon Target Detector (BTD) subsystem.- The BTD shall provide for the detection and reporting of the position, altitude and identity of transponder equipped aircraft. Beacon input shall be obtained from the Air Traffic Control Beacon Interrogators, ATCBI or from the Mode S receiver when operating in an all ATCRBS mode. The BTD shall also receive primary radar target reports from the C&I processor for the purpose of performing radar/beacon target merging before sending the data on to the radar report-to-track association and output formatting functions of the SP.

3.12.5.5.1 Beacon video.- The beacon video provided to the BTD will be serial video data streams which will contain the aircraft code train replies. The analog video will be the output of a linear receiver which will have been realigned to remove the short stagger which may have been introduced in the beacon interrogator, but may remain staggered as the result of external stagger requirements such as the search radar. In either instance, the video will be synchronized with the beacon mode pair trigger. The video will have been subjected to the effects of gain time control (GTC) circuitry in the receiver (ahead of any quantizer). The nominal and extreme characteristics of the video will be as follows:

		Nominal	Extreme
(1)	Amplitude	+2.0V	+1.5 to +8V
(2)	Noise	+0.5V	0.0 to +1.0V
(3)	Baseline	0.0V	-1.0 to +1.0V
(4)	SNR	4:1	1.5:1 to 1000:1
(5)	Pulse Duration	0.45 us	0.05 to 2.0 us*
(6)	Rise Time	0.1 us	0.05 to 0.2 us
(7)	Fall Time	0.2 us	0.05 to 0.3 us
(8)	Impedance	75 ohms	70 to 80 ohms

*Note: The wider pulsewidths reflect the widths that may result from overlapped pulses in the replies from two or more aircraft. The width of noninterfering pulses will not exceed 0.60 microseconds.

The amplitude and noise values listed above are average peak values. The analog video's noise will be the "dense" noise characteristics of thermal noise in linear receivers. Because of the GTC action, it will increase with range from near zero at close range to the normal thermal noise level, where it will remain for the remainder of the sweep. Because of slow changes in receiver gain, the normal thermal noise may vary in amplitude over a period of time at a rate of up to 0.3V per second.

3.12.5.5.2 Beacon mode pair trigger.- The BTD shall accept the beacon mode pair triggers generated within the beacon interrogator and use them to determine the range and beacon mode of the aircraft's video reply trains. The triggers will consist of a single pair of pulses per sweep, the separation of which will indicate the mode of that radar sweep. The first pulse to occur is designated P1 and the last pulse is P3. P3 is stationary with respect to beacon range zero. Any interlace sequence or combinations of Modes 2, 3/A, and C may be provided by the beacon radar. The nominal and extreme characteristics of the beacon mode pair trigger will be as follows:

		Nominal	Extreme
(a)	Amplitude	+15V	+10 to +60V
(b)	Baseline	0.0V	-0.5 to +0.5V
(c)	Width	1.0 us	0.5 to 2.0 us
(d)	Rise Time	0.08 us	0.15 us max
(e)	Fall Time	0.3 us	0.5 us max
(f)	Pulse Spacing (P1 to P3)		
	(1) Mode 3/A	8 us	7.8 to 8.2 us
	(2) Mode C	21 us	20.8 to 21.2 us
	(3) Mode 2	5 us	4.8 to 5.2 us
(g)	Impedance	75 ohms	70 to 80 ohms

3.12.5.5.3 Antenna azimuth data.- The BTD's azimuth input signals are described in paragraph 3.8.8 and subparagraphs thereof.

3.12.5.5.4 Failure indicators.- Provisions shall be included to monitor the performance of the range and azimuth circuits. Logic circuits shall monitor the unit operation and indicate, by transferring appropriate flags the following failures:

(a) Azimuth counter failure

(b) Azimuth reference pulse failure

(c) Range clock out of tolerance. The range timing logic circuitry shall indicate an alarm for any pretrigger not within the acceptance gate.

(d) Range counter failure

(e) Beacon pretrigger failure

(f) Mode trigger failure

3.12.5.5.5 Video selection and conditioning.- The video and conditioning logic shall provide for reception and analog processing of beacon video input signals. Signals received shall include live beacon video (with or without triggers), external test video, and internal test video.

3.12.5.5.5.1 Internal test video.- Two types of test video shall be supplied. The selection and control of the test videos will be by the BTD, or at the Contractor's option may be incorporated in the primary radar test target generator (paragraph 3.13.3).

3.12.5.5.5.1.1 Real-Time Quality Control (RTQC) test target.- An RTQC target shall be generated and inserted at the input of the video conditioning logic.

3.12.5.5.5.1.2 Test target generator.- A test target generator shall provide for generation of A/D test replies for insertion into various logic groups of the BTD. The reply video parameters and the insertion point shall be controlled by the BTD. The type of test replies generated shall be as follows:

(a) Analog beacon reply pulses consisting of bracket framing pulses (F1 and F2), 13 code pulses and one SPI pulse. This type of test reply, when selected, shall be inserted into the Video Selection and Conditioning Logic.

(b) Lead edge hit data consisting of 103.5 nsec. hits representing lead edge positions of beacon reply pulses, F1, F2, Code and SPI. This type of test reply, when selected, shall be inserted into the Reply Decoding logic.

(c) Binary range, code, and SPI data. This type of test reply, when selected, shall be inserted into either the Analog Channel or Output Buffer logic.

<u>3.12.5.5.6 Detailed functional requirements for the Beacon Target Detector (BTD)</u>.- The BTD shall receive antenna azimuth data, beacon mode and range data, beacon video, test video, and a test indicator. The BTD shall contain a video quantizer and appropriate bracket detection, code extraction, reply degarbling, and timing circuitry. The quantizer shall provide a single-bit output data stream. If quantized video is provided by the beacon radar, it shall be possible to pass the video through the BTD quantizer or, as selected by simple and convenient internal means, to insert the quantized video immediately after the quantizer. When the BTD quantizer is bypassed in this manner, the externally-quantized video shall be processed by the BTD in exactly the same way as the external analog signal, with the sole exception of the quantizing function.

<u>3.12.5.5.6.1 Video quantizer</u>.- Upon entering the BTD, the beacon video shall be subjected to a one-half amplitude quantizing function and compared to selected amplitude and pulsewidth acceptance criteria. Those pulses meeting both criteria shall be provided to the bracket detector; all other signals shall be inhibited. Only a video pulse which, at its 50 percent amplitude point (as measured from the video baseline to the peak amplitude of the pulse), meets both of the following acceptance criteria shall be passed:

(a) <u>Amplitude</u>.- A variable threshold shall be provided to establish the acceptable data slice level. Any video pulse which exceeds this threshold by 10 mV or more shall be considered acceptable. The threshold shall be adjustable from less than 0.20V to more than 2.0V and shall not vary more than 50 mV from the set value over a 168-hour interval in any environmental condition permitted in paragraph 3.3.2. In the event that the threshold adjustment is implemented digitally, the adjustment granularity shall be no greater than 50 mV. The threshold shall be fixed, that is, independent of the input noise.

In addition, it shall be possible to have the threshold be automatically adjusted in response to noise amplitude variations such that it maintains a fixed relationship with respect to the average peaks of the video noise outside of the GTC area. This variable threshold shall not vary with the GTC effect but shall follow the longer term thermal noise variations. The relationship of the variable threshold to the video noise estimate shall be able to be adjusted by a separate control over a range of from at least 0.2V below the noise to at least 1.0V above the noise. Once established, this relationship shall not vary by more than 50 mV under the conditions specified above for the fixed threshold. In the event that this control is implemented digitally, the granularity of the range of values shall be no greater than 50 mV. The estimate of the video noise shall be determined by measuring the video noise in a range window for the last 100 or more consecutive beacon sweeps and calculating the average value of the peaks in the noise samples. The window shall be greater than 63 nanoseconds but less than 125 nanoseconds long. It shall, by simple internal means, be able to be placed at any range from less than 60 miles to within 20 microseconds of the maximum range permitted by the beacon radar's PRF, with a granularity of five miles or less.

(b) Pulsewidth.- A variable width threshold shall be provided to establish the minimum acceptable reply pulsewidth criterion. Any video pulse which exceeds this threshold shall be considered acceptable. The threshold shall be adjustable from less than 0.15 us to at least 0.35 us in increments of 63 ns or less and shall not vary more than 63 ns from the set value under any of the environmental conditions permitted by paragraph 3.3.2. The width of the pulse passed to the bracket detector shall be within 63 ns of the video pulse's width, as measured at its 50 percent amplitude point, providing that it exceeds this established minimum pulsewidth criterion. The width threshold circuitry shall be implemented using digital logic which is synchronized with and operates at multiples of, the basic BTD range clock.

The adjustment and selection of the quantizer's acceptance criteria (not including the range of the noise sample window) shall be made by simple and convenient internal controls or wiring changes which may be performed while the machine is in operation. The actual criteria applied to the video shall be available for in-operation observation during the adjustment process.

3.12.5.5.6.2 Bracket detection.- The BTD shall recognize the presence of the beacon framing pulses (F1 and F2) in the video reply train by sensing the nominal 20.3 us spacing between their leading or trailing edges (refer to FAA Order 1010.51A, Attachment 1). In the case of leading-edge detection, the leading edge of F1 shall be the reference edge of the reply for range and code extraction. In the case of trailing edge detection, the trailing edge of F1 minus 0.45 us shall be the reference edge for range, and the trailing edge of F1 shall be the reference edge for code extraction, which shall be done on the trailing edge code. The F1-F2 spacing shall be sensed with a tolerance which is adjustable by simple internal means. This adjustment shall be implemented by sensing pulse spacings which occur within an integral number of range clock pulses of the nominal 20.3 us spacing provided that the range clock's frequency permits the specified tolerances to be met. The minimal tolerances within which the BTD shall declare brackets and outside of which the BTD shall not declare brackets shall be as follows for a BTD range clock period of 85 to 125 ns.

Tolerance Setting	Accept Tolerance	Reject Tolerance
±0.1 us	±1 clock periods	±2 clock periods
±0.2 us	±2 clock periods	±3 clock periods
±0.3 us	±3 clock periods	±4 clock periods

For a BTD with a range clock period outside of the 85 to 125 ns interval, the tolerances shall be as follows:

Tolerance Setting	Accept Tolerance (with respect to 20.3 us)	Reject Tolerance (with respect to 20.3 us)
±0.1 us	±100 ns	±250 ns
±0.2 us	±200 ns	±375 ns
±0.3 us	±300 ns	±500 ns

The bracket detection logic shall recognize and inhibit the false bracket detection output that could otherwise occur because of the presence of the C2 and Special Position Identification (SPI) pulses in a reply train. Detection of a valid bracket pair shall cause the sampling of the data mode, range, and azimuth registers for use in the code extraction and garble sensing circuits, and for inclusion in the BTD's output reply word.

The BTD shall detect the presence of Mode S replies and reject the false ATCRBS bracket declarations generated from them. This detector shall recognize the presence of the Mode S preamble and data waveforms (refer to FAA Order 6365.1A, appendix 1) and blank the bracket detections (F1, F2 pairs) for the duration of the reply in the ATCRBS decoder. The Mode S reply data shall be considered as fruit and all bracket detections resulting from the reply shall be discarded prior to the code extraction processes. A maintenance switch shall be provided to disable this processing feature.

A Mode S preamble shall be detected when valid pulses are detected in all four positions of the preamble waveform, with at least two pulses (adjustable from two to four) declared with clear leading edges. A preamble shall be declared when a valid pulse is followed by three additional valid pulses located at 1.0, 3.5, and 4.5 microseconds. At least two of the four pulses shall have clear leading edges in agreement with the above spacings with the same tolerances specified for ATCRBS bracket detections, except that there shall be only two selectable settings ± 0.1 us and ± 0.2 us.

The preamble detection process may be implemented using the bracket decoding shift register. The time span of the Mode S reply detection process shall not exceed 20.3 microseconds to permit disabling bracket detections when the first preamble pulse reaches the F1 tap.

Upon successfully detecting the preamble the bracket detectors shall be inhibited for the 8 microsecond preamble pulse period plus the 56 microsecond information pulse period and until the time between consecutive valid pulses exceeds 1.1 to 1.25 us.

3.12.5.5.6.3 Code extraction.- The sensing of the beacon framing pulses shall cause the sampling of all of the information pulses which may be associated with the reply. The nominal positions and pulsewidths of the 13 code pulses and the SPI pulse will be as specified in Attachment 1 to FAA Order 1010.51A. The particular reference used for each individual bracket detection (paragraph 3.12.5.5.6.2) shall be used to establish the nominal sampling positions of the information pulses associated with that bracket. Regardless of the reference used, the sampling shall be accomplished using the same tolerances as specified for bracket detection, except that there shall be only two selectable settings for the code data sampling tolerance: ±0.1 us and ±0.2 us. The sampling technique shall not necessarily require a leading edge to detect a code pulse. The selection of the code data tolerance shall be accomplished by simple internal means and shall be separate from those of bracket detection or garble sensing.

3.12.5.5.6.4 Garble sensing.- The BTD shall check the bracket and code data for garble conditions that may exist which would interfere with the target detection and code validation processes. Interleaved replies are, by definition, not mutually interfering and shall not cause a garble declaration regardless of the extent of the interleave. Similarly, closely-spaced replies do not mutually interfere. Therefore, all replies involved in an interleaved or a closely-spaced reply condition, or a combination thereof, shall be correctly and unambiguously decoded and processed without garbling. The BTD shall recognize the false, "phantom" brackets which can occur in the closely-spaced reply condition when nonframing pulses in different replies occur at the 20.3 us framing interval. All such phantom brackets shall be detected and eliminated without garbling or otherwise affecting the two correct replies. All bracket and code data shall be retained long enough to permit checking for potential garbling caused by possible overlapped replies. The tolerances for this check shall be implemented in the same manner as those of the code extraction circuitry, except that the tolerances shall be ±0.2 us and ±0.4 us. A separate and internal means of control is again required. The delay inherent in this check shall not cause incorrect range or azimuth reporting of any resulting target. The information data associated with overlapped replies which cannot be unambiguously resolved shall be destroyed (set to all zeroes) and a garble flag set in the associated reply word. The bracket detections of the overlapped replies shall remain intact and shall be available for use in the target detection process.

3.12.5.5.6.4.1 Special Military Replies.- The BTD shall contain appropriate circuitry to perform detection of a Mode 3/A "Military Emergency" condition. These special military responses to Mode 3/A are defined and shall be processed as specified below:

(a) In lieu of the civilian transponder's single emergency (code 7700) reply, some military transponders will transmit four complete reply pulse trains, with the first framing pulse of the succeeding reply trains occupying the SPI pulse position of the preceding pulse train. The emergency code of 7700, if it is transmitted at all, may appear in the first reply train with either the normal Mode 3A code or an all-zero code in the remaining trains. The BTD shall recognize this reply format even if the second or third reply train (but not both) is missing, and shall report it as a single reply with a military emergency flag bit set. The BTD output shall include the range, azimuth, and code of the first reply train only.

3.12.5.5.6.4.2 Military IDENT.- In lieu of the single SPI pulse following the second framing pulse (F2) by 4.35 ± 0.1 us, the complete code train is repeated, with the first framing pulse (F1) of the second code train occupying the SPI pulse position of the first code train. These latter replies shall be recognized as military replies.

3.12.5.5.6.5 Beacon Target Detector (BTD) timing.- The BTD shall contain appropriate range clock generation circuitry. The clock's frequency shall be such that an integral number of clock pulses occur in the nominal video code pulse interval of 1.45 us and bracket interval of 20.3 us. The least significant bit of the range word used for the bracket detection reply shall be no greater than 125 ns. The leading edge of the P3 pulse of the beacon mode trigger shall define beacon zero range. All time or range manipulations in the BTD shall use the BTD range clock or multiples thereof. The conversion of BTD range to nautical miles for a target report shall be performed in the BTD processor. A range alarm shall be indicated if the clock fails or changes frequency such that the design value number of clock intervals yields a value more than 20 ns from the correct bracket spacing of 20,300 ns. The BTD shall also decode the mode trigger pulse spacings for Modes 2, 3/A and C in any interlace sequence. If an illegal or out-of-tolerance pulse spacing is received or if the P3 pulse fails, a mode trigger alarm shall be indicated. The BTD shall contain appropriate azimuth word generation circuitry. The input data shall be in the form of ACP pulse data (4,096) ACP's per ARP. Thus, the least significant bit in the azimuth word shall be 0.088 degrees. The leading edge of the ARP shall define an azimuth reference point. The BTD zero azimuth shall be able to be set at any position with respect to the ARP reference with a granularity of 0.088 degrees. This adjustment shall be made by simple internal means. All azimuth manipulations in the BTD shall use this azimuth reference and position granularity. An azimuth alarm shall be indicated if the azimuth data does not increment correctly within 10 percent of the nominal site-adapted ACP interval, or if there are not exactly 4,096 ACP's per ARP.

3.12.5.5.6.6 Target detection.- The BTD shall utilize bracket declarations, ungarbled code data, and appropriate status flags and timing data from the use in the processor's target detection process. The reply data shall be compared in range, azimuth, and code with previously received replies such that all Mode 2, 3/A and C replies from a single aircraft are grouped into a single target report. No reply shall be correlated with, or used in formulating, more than a single target report. If a choice of targets exists for a given reply, the reply shall be correlated with the most similar target file, and the special beacon target indicator flag shall be set in all target files considered for such correlation. Each reply that fails to correlate with an existing target file shall cause the formation of an initial target file. The correlation criteria shall be a fixed software function of the detection algorithm and shall not be accessible to operation or maintenance personnel. Replies from both Modes 2, 3/A and C interrogations shall be used in the target detection process.

The specific detection algorithm implemented in the BTD shall be either a sliding window or, at the contractor's option, a type of sequential observer. The algorithm shall use a fixed range cell technique for allocation of reply range data or, optionally, a floating range cell technique. The selected algorithm, including the appropriate range allocation technique, shall be implemented in such a manner as to meet or exceed the accuracy, resolution, split and false target rates, and probability of detection requirements specified in paragraph 3.4.3.4 under any permissible combination of radar and aircraft conditions as specified in paragraph 3.4.3.2. The selected technique shall be able to resolve and correctly report at least four stationary, interleaved targets where the F2 pulses of the furthest replies occur less than 3.0 nmi after the SPI position of the first target's replies. Any embellishment to the basic target detection algorithm which is required to meet these requirements shall be provided. All fixed parameters necessary to optimize the detector to a reply situation, including the lead and trail edge criteria, in the case of the sliding window length, shall be able to be adjusted by simple internal means.

3.12.5.5.6.7 Code validation.- The BTD shall attempt to validate the ungarbled Mode 2, 3/A, and C codes, including SPI, X, and military emergency bits which are correlated with a target during the target detection process. The validation process shall start only after T_V target detection replies have been correlated with a specific target, where T_V is the begin validation threshold. The value of T_V shall be manually adjustable from less than two to at least six in unit increments by a simple internal means. A data code shall be validated if, during the target detection process, V or more consecutive replies to the same interrogation mode identically compare on a bit-for-bit basis, where V is the validation count. The value of V shall be manually adjustable from less than two to at least six in unit increments by a simple internal means. The validation process shall be conducted separately and shall set separate code-valid flags for the following code bits: 12-bit Mode 3/A, 12-bit Mode 2, Mode 2 X-bit, 12-bit Mode C, SPI, Mode 3/As X-bit, and the military emergency bit. If the validation attempt is not successful, the appropriate code-valid flag shall remain not set and, in the cases of the

Mode 3/A and Mode C 12-bit codes only, the code associated with the highest validation state before the completion of the target detection process shall be included in the output target report. If the validation states are of equal value, the first code received will be sent. All output reports shall contain the validation state of the output code. In all other instances, the validated code or codes shall appear in the target report.

Upon successful completion of the validation process, the incoming code data shall continue to be inspected and utilized by the target detector to resolve any adjacent targets. If the target detection process correlates a Mode 2 or 3/A reply with a target file and that reply does not compare with the file's validated Mode 2 or 3/A code, that fact shall be stored in the file. When the number of such correlated but noncomparing replies in the file exceeds the value NC (no compare) the target file shall be destroyed if it does not yet contain enough data for a valid target. If it is a valid target, it shall be completed and output without any additional data input but with the special beacon target flag set. The value of NC shall be manually adjustable from less than two to at least six in unit increments by a simple internal means.

<u>3.12.5.5.6.8 Code transformation</u>.- After validation and before entering the target report into the output buffer, the BTD shall transform the Mode 2, 3/A and Mode C code data from the aircraft reply format to the digital message format. The Mode 2 data shall be rotated one bit to the right such that it conforms with the format of Appendix III, paragraph 30.8.2, field 6, bit positions 66 through 77 and paragraph 30.8.3, field 6, bit positions 66 through 77. The Mode 3/A reply grouping of C-A-B-D shall be transformed to the binary-coded-decimal format of A-B-C-D. When the military emergency bit is validated, the aircraft Mode 3/A code shall be replaced with Code 7700 and the Mode 3/A validation flag shall be set. The Mode C reply grouping of C-A-B-D shall be transformed to the appropriate 12-bit binary code (a sign bit plus 11 data bits) indicating the aircraft's reported pressure altitude. Negative altitudes, in addition to setting the sign bit, shall be reported in 2's complement form. Refer to FAA Order 1010.51A, figure 1 of attachment 1, for additional Mode C conversion requirements.

<u>3.12.5.5.6.9 Beacon target position bias correction</u>.- The BTD shall provide for the correction of the position of all beacon targets to eliminate any positional bias errors introduced by the target detection process. This correction shall be a software parameter which is not subject to operator control. It shall be a single fixed value, unless the selected target detection algorithm requires a dynamic correction technique to meet the established performance requirements. In the latter instance, the dynamic correction shall be implemented in such a manner that it can be easily modified at such time as the target detection algorithm is modified. The BTD shall also transform the target's range from Beacon Range Clock (BRC) intervals to nautical miles as a part of this bias correction process.

In addition to this correction, separate, manual means to insert corrections shall be provided to offset any range or azimuth errors caused by antenna alignment, search-to-beacon radar timing or other sources of error which may exist external to the BTD. These two corrections are in addition to similar adjustments required elsewhere and shall not invalidate the accuracies of internally-generally beacon test targets. They shall be established and inserted by simple and convenient internal controls. The range correction shall provide for biasing the target report range from zero to at least 5.0 nmi in either direction from the nominal target position in increments of 1/32 nmi or less. The azimuth correction shall provide for biasing the target report azimuth from zero to at least 10 degrees in either direction from the nominal target position in increments of 0.088 degrees.

<u>3.12.5.5.6.10 Beacon run length processing</u>.- The BTD shall be able to inhibit beacon targets which have unacceptable runlengths and output those which are of an acceptable runlength. An acceptable beacon target is one which consists of no fewer than SRB ACP's nor more than LRB ACP's, where SRB indicates a short runlength threshold for beacon targets and LRB is their long runlength threshold. A target file which does not extend for at least SRB ACP's or which extends for more than LRB ACP's shall not result in a final target report. The values of LRB and SRB shall be able to be independently set in each of at least 16 independently established range and azimuth sectors. SRB shall be variable from zero to at least 35 and LRB shall be variable from less than 20 to at least 230 in integer values. The start-stop range azimuth values for each sector shall be able to be independently set anywhere in the BTE's coverage with a resolution of 0.7 degrees and 0.5 nmi or better. Each sector shall be able to provide full azimuthal coverage (360 degrees). The control of the sectors and values for SRB and LRB shall be exercised from the front panel. This runlength discrimination feature shall be enabled or disabled from the front panel and shall not apply to beacon strobe or beacon real-time quality control (RTQC) test targets.

While beacon run length is processed in ACP's, a count of beacon replies shall be collected for output data purpose.

<u>3.12.5.5.6.11 Beacon processing range</u>.- The BTD shall be able to inhibit the reporting of beacon targets which are not within a site-selectable range coverage. The beacon minimum range shall be variable from zero to at least 32 nmi and the beacon maximum range shall be variable from zero to the maximum BTD range. The values shall be separately adjustable in increments of 0.5 nmi or less by simple internal means. Neither function shall affect the reporting of RTQC or self-test targets.

<u>3.12.5.5.6.12 Beacon and search target merge</u>.- The BTD shall be able to correlate the separate search and beacon target reports which result when the same aircraft target is detected by the beacon radar and the search radar. The correlation process may be implemented in the BTD processor or, at the contractor's option, elsewhere in the SP. The inclusion of the correlation requirements in this paragraph shall not be interpreted to require that this function necessarily be implemented in the BTD.

The correlation shall be accomplished such that a single beacon target report, with the radar-reinforced bit set, is output for a single aircraft which is detected by both the primary and secondary radar systems. The correlation algorithm shall work on completed search and beacon target reports only, and shall be accomplished prior to entering the target report in the output buffer queue for transmission as a final target report. The correlation algorithm shall correlate only those targets which meet established range and azimuth relationships. These relationships shall be initially determined by the contractor and approved by the Contracting Officer prior to the start of equipment production. The correlation criteria shall be able to be modified by appropriate software changes. The correlation procedure shall not delay any target more than 1/32 of a scan. The beacon-search reinforced message shall contain either the position of the search target, the position of the beacon target, the search range and beacon azimuth, or the beacon range and the search azimuth. The selection of the data source for the position report shall be accomplished by a simple internal means. A single target which is detected by both radars shall be reported as a single correlated beacon message at least 99.9 percent of the time.

<u>3.12.5.5.6.13 Beacon offset</u>.- The BTD shall be able to offset the range of beacon targets in order to defeat the correlation algorithm and, thus, collect both search and beacon target data from aircraft returns. The offset shall add 0.500 nmi to the otherwise correct range of all beacon targets except those generated internally for the RTQC function. The offset shall be able to be enabled or disabled from the front panel. When the offset is enabled, a conspicuous notation to that effect shall be displayed on the maintenance console and the condition reported in the BTD status report.

<u>3.12.5.5.6.14 Beacon Target Dection (BTD) output target message contents</u>.- The BTD shall provide its output data to the SP data bus for distribution. The specific formats of the beacon target report and BTD status report messages provided by the BTD to the SP data bus shall be as defined by the contractor. The messages must contain at least the following information:

(a) <u>Beacon Target Report</u>

(1) RTQC - This bit shall be set only for the beacon RTQC test target.

(2) Test - This bit shall be set if the test indicator was present for one or more of this target's replies.

(3) Message label - A unique bit arrangement which identifies the message as a BTD output target report.

(4) Code validation and emergency flags - The six code validation flags (Mode 2, Mode 2 "X", Mode 3/A, Mode 3/A "X", Mode C, and Identification or SPI) shall be set upon successful completion of their respective validation processes. The presence of a validated 7600 or 7700 Mode 3/A code shall be sufficient to set the respective emergency flag.

(5) Radar reinforced - This bit shall be set only if search-beacon correlation is performed in the BTD and if the correlation criteria have been met for this target.

(6) Range - The average range of the individual replies which make up this report. The LSB shall be 1/64 nmi and the MSB shall be 32 nmi.

(7) Not used.

(8) Azimuth - The average azimuth of the individual replies which make up this report. The LSB shall be 0.088 degrees and the MSB shall be 180 degrees.

(9) Discrete - This bit shall be set whenever the report contains a discrete Mode 3/A code.

(10) Code data for Modes 2, 3/A and C - These bits shall contain the validated or unvalidated code data of the target. A given code field shall consist of all zeroes if that particular mode was not interrogated or if the aircraft did not reply, was garbled, or replied with framing pulses only to Mode 2 or Mode 3/A interrogations.

(11) User Bits - The FAA and Air Force user bits shall be set in each beacon target report.

(12) Special Target - This bit shall be set as specified in 3.12.5.5.6.6.

(13) Run Length - Indicate run length of beacon targets.

(b) <u>Beacon Target Detector (BTD) status report</u>

(1) Range alarm
(2) Azimuth alarm
(3) Output alarm
(4) Overflow alarm
(5) Beacon mode trigger alarm
(6) Results of the operational self-test
(7) Beacon offset
(8) Beacon run length discrimination status on/off

If the beacon-search correlation is not performed in the BTD, the beacon target report need not contain the radar-reinforced flag bit.

<u>3.12.5.5.6.15 Beacon Target Detector (BTD) self-test</u>.- The BTD shall routinely test itself, check the test data against established norms, and report the results of the check. Two types of testing shall be incorporated into the self-test function: operational and diagnostic.

3.12.5.5.6.15.1 Operational self-test.- The operational self-test shall operate continuously when the BTD is in the normal operating mode, whether or not the associated channel is actually on-line. The BTD shall, via the system data bus, direct the test target generator to generate the appropriate test signals to simulate the types and quantities of test targets required to establish that the complete BTD is functioning correctly. The formats of these messages shall be as defined by the contractor. The test target generator output for these operational self-test functions shall not contain the test indicator signal, but shall appear as normal, live target data. External beacon video shall be inhibited for the minimum time necessary to prevent interference or garbling of the self-test signals. The test signals provided shall include the following conditions at a minimum:

(a) Framing pulses with acceptable and unacceptable pulse spacings,

(b) Code pulses that are correctly and incorrectly located with respect to both normal and wide framing pulses,

(c) Reply codes and range separations which verify the correct elimination of phantom and C2-SPI false brackets, the proper detection of interleaved and overlapped replies, and the correct correlation and range resolution of the replies by the target detection algorithm, and

(d) Simulated Mode 2, 3/A and C targets which verify the correct operation of the target detection, code validation, code transformation, target position bias correction, and run length processing and encoding functions.

The operational self-test targets shall be generated as close to the adapted BTD maximum processing range as is possible and, in contrast with the RTQC test targets, shall be for internal status monitoring only. All self-test target data shall be capable of being displayed on the maintenance console but shall not be transmitted to the data sets. The test signals shall be injected immediately following the quantizer.

Another facet of the operational self-test is the validation of the search-beacon correlation algorithm. This particular self-test function shall be implemented in the processor in which the search-beacon correlation is performed.

The operational self-test shall also detect any loss of data as the result of the overflow or failure of any register, buffer, or complete memory system within the BTD. Normal adjustments of the BTD's parameters such as beacon offset, maximum range, run length discrimination, and other similar parameters shall not impair the effectiveness or accuracy of the operational self-test. A complete operational self-test cycle shall be completed and the results updated at least once every four antenna scans.

3.12.5.5.6.15.2 Diagnostic self-test.- The BTD's diagnostic self-test shall be able to be initiated only when the associated channel is off-line via the Performance Monitor Subsystem (paragraph 3.13) and shall include the following as a minimum:

(a) A check of all microprocessor operational program memories to insure that the correct data is in each memory location.

(b) A thorough, rigorous check of all random-access and scratchpad memories to ascertain their operating conditions.

(c) Verification of the correct operation of each computing element in each microprocessor.

(d) Verification of the ability of the processor to process internal data in the absence of external stimuli.

(e) Verification of the correct operation of the alarm detection circuits.

(f) Verification of the correct operation of the output message generation functions.

The test signals necessary for tests (e) and (f) above shall be generated, inserted, and able to be displayed in the same manner as the operational self-test target signals.

3.12.5.5.6.16 Beacon Target Detector (BTD) status monitoring and reporting.- The BTD shall monitor the status of the beacon offset and the results of the operational self-test, and provide all results to the Performance Monitor Subsystem (paragraph 3.13).

3.12.5.6 Surveillance Processor (SP) primary radar performance requirements.-

3.12.5.6.1 Overall performance.- In addition to the BTD function, the SP shall provide scan to scan correlation of all radar reports from C&I except radar reports of confidence level 000 (radar reports from roads). If a C&I target is used to set the radar reinforced bit in a beacon message, the radar only report for that message shall not be output from the SP, although it shall be used for the scan to scan correlation function of the SP. By providing scan to scan correlation on all radar reports, except those already mentioned, the loss of beacon detection will not cause loss of correlated radar reports. The complete sequence of surveillance steps shall be performed a minimum of 32 times per scan of the radar and will be based on the azimuthal data provided by the ACP's and ARP's from the antenna; i.e., radar data shall be collected in a buffer and the scan-to-scan correlation programs then sequentially process the data. Since aircraft cross sector boundaries at different stages of the processing, sector delays (a total of seven), relative to the sector for which radar data is currently being input to the scan-to-scan correlation, must be handled (paragraph 3.12.5.5.3). A state diagram for the scan-to-scan correlator (SP) is shown in figure 3.12.5-1. The

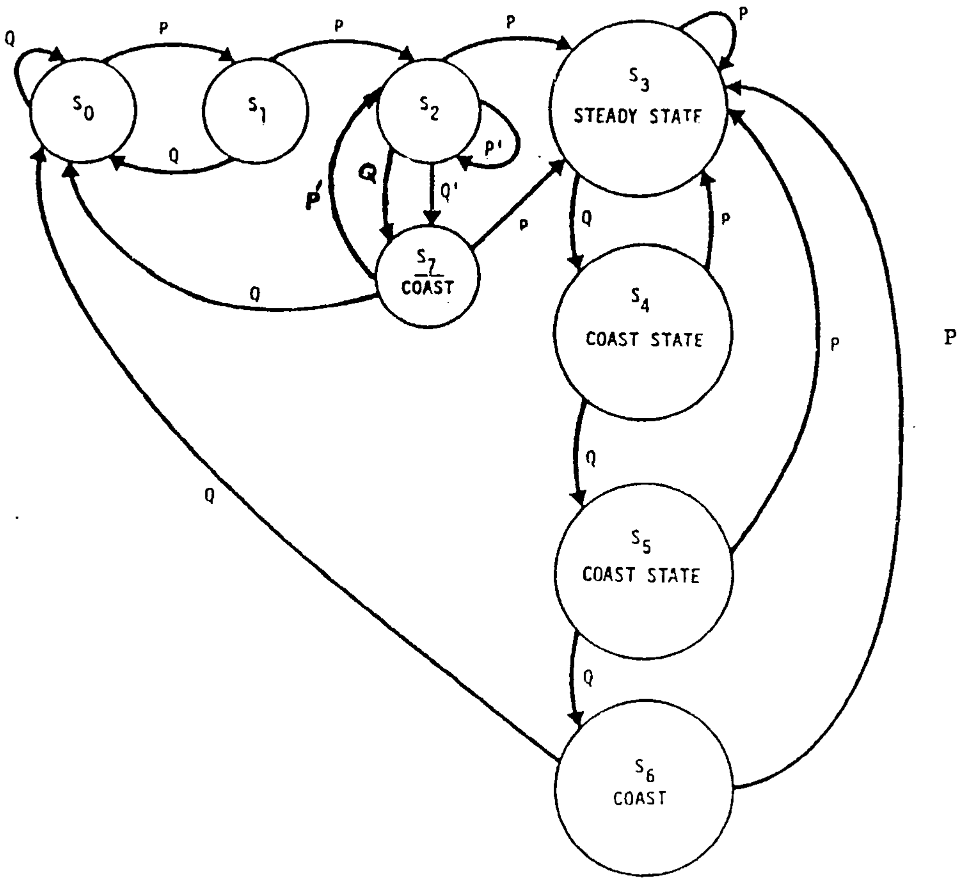


FIGURE 3.12.5-1

SCAN-TO-SCAN CORRELATION STATE DIAGRAM

process proceeds as follows: Aircraft which are out of track are in state S_0. Upon first detection, the track enters state S_1. A small area is next established about the position of this first detection with dimensions rho and theta equal to the distance a maximum velocity aircraft can travel, plus an allowance for radar measurement error in the range and azimuth dimensions. If on the next scan a target is reported within this association area, the arrow marked "P" in figure 3.12.5-1 is followed to promote the track to state S_2. If no target is reported within the association area, the arrow "Q" is followed. As further detections occur, the track is promoted to higher states until it reaches the steady state. If the track is in a higher state than S_1, other values of rho and theta will have been established in the track update process. The transitions P' and Q' represent targets that are followed by a track file which has not yet satisfied a minimum distance traveled requirement.

3.12.5.6.2 Target report-to-track association.- An attempt shall be made to associate each input radar target report, except those of confidence level 000, with one or more existing tracks. To qualify for association, a target report must be within specified range and azimuth windows surrounding the predicted position of the track and be eligible for track initiation or correlation (paragraph 3.12.4.3.7.1) during the current scan. These windows represent the range and azimuth prediction/measurement errors, and an allowance for target acceleration since the last scan. The dimensions of these windows shall be a function of the range and state of the track as follows:

Track State	Azimuth	Range
S_1	± maximum target velocity, nominally 600 nm/hour	±maximum target velocity, nominally 600 nm/hour
S_2, S_3, S_7	± (14 ACP + 0.5g acceleration)	±4/32 nm
S_4	± (14 ACP + 0.5g acceleration)	±7/32 nm
S_5, S_6	± (20 ACP + 1.0 g acceleration, single scan)	±7/32 nm

Each input target report may associate with any track file that has not been updated within the previous one half scan. However, the search for associations may be limited to reasonable range and azimuth sectors to control the computational requirements of the association process. The use of discrete beacon codes shall be permitted in the association process. In the absence of a merged report case (a search report merged with a beacon report) the association logic shall revert to the rules stated above for the search only report data.

3.12.5.6.3 Correlation.- The function of this module shall be to resolve target report-to-track file conflicts. Possible nonunique target report-to-track file associations shall be resolved to provide a one-on-one, or zero-on-one correlation between target reports and track files. This process shall be delayed so that new target reports received from late azimuths can be included in the search for associations. This task will be delayed a certain number of sectors before resolving association(s) and outputting to update. For the case where only one target report was associated with the track file, and that target report was not associated with any other track file, or a discrete beacon code match can be achieved, the correlation is trivial (e.g., no conflict exists), and the target/track update/display processing continues. In the case where more than one target report associates with the track, and at least one of the target reports is not associated with another track (or is not required for another track to have a target report associated with it), then the target report with the smallest association measure (defined below) which will not result in the loss of a target report-to-track association for another track, shall be correlated with the track.

$$\text{Association measure} = \left(\frac{(\Delta\,\text{rho})^2}{(\delta\,\text{rho})^2} + \frac{(\Delta\,\text{theta})^2}{(\delta\,\text{theta})^2} \right)^{1/2}$$

where: δ rho and δ theta are the range and azimuth windows for a track in State 2. Δ rho and Δ theta are the actual change in range and azimuth respectively. In the case where all of the associated target reports are necessary for another track to have an associated target report, then the target report correlated shall be the target report with the smallest association measure, and absolute preference shall be given to a target report associated with another track which is not in State 3. However, a target report shall not be correlated with a track when this will result in the loss of an association to another track, where the association measure for the other target report-to-track pair is smaller. Association conflict resolution shall be performed using track age as a discriminant dealing with each closed conflict set sequentially.

3.12.5.6.3.1 Minimum distance requirement.- A track shall not be allowed to enter either State 3 or State 7 until it has either moved 1/4 nm in range or four CPI's in azimuth. Target reports at ranges greater than 20 nm are exempt from this requirement. The selection of range and azimuth minimum distance requirement shall be a parameter adjustable in range and azimuth in increments of 1/16 nm up to 5/16 nm and from one to five CPI's.

3.12.5.6.4 Track update.- The correlation process has resulted in either zero or one target report being associated with a track file. The track file state is now updated according to the state diagram. If the track file is not dropped (set to State-0, S_0) and has a correlated target report, it has its position updated as described below. Otherwise it is coasted using the previous reported rho, theta, or x, y used on the previous scan (previous update). When the range of the new target report is equal to or less than 8 nm, a track file update shall be performed using a two-point interpolation in x, y coordinates as follows:

x' = measured position this scan

x'' = measured position past scan

$\dot{x} = x' - x''$

$\dot{y} = y' - y''$

predicted $x = x' + \dot{x}$

predicted $y = y' + \dot{y}$

After the track file has been predicted ahead to the next scan, the position shall be converted back into rho, theta coordinates. When the range of the new target report is greater than 8 nm, the prediction shall be done in rho, theta coordinates, using alpha, beta smoothing for the theta prediction.

$\dot{\text{theta}}$ = $\text{OLD}\dot{\text{theta}}$ + beta (theta' - OLDtheta)

$\dot{\text{rho}}$ = rho' - rho"

predicted theta = OLDtheta + alpha (theta' - OLDtheta) + $\dot{\text{theta}}$

predicted rho = rho' + $\dot{\text{rho}}$

rho', theta' = measured position present scan

rho", theta" = measured position past scan

OLDtheta = last predicted theta value

$\text{OLD}\dot{\text{theta}}$ = last $\dot{\text{theta}}$ value

The values of alpha and beta used in the process for smoothing theta are a function of the target report quality. The quality attribute is a function of the primitive target reports which contributed to the centroided azimuth of the target report on the current scan, and is set in the C&I processor. Target reports with low quality (possible large error in azimuth position measurement) are smoothed heavily, and target reports with higher quality ("better" measurement of the azimuth position) are smoothed less. The values of alpha, beta to be used in predicting the track file position for the next scan are as follows:

Quality	alpha	beta
3	1.0	0.9
2	1.0	0.9
1	0.9	0.7
0	0.6	0.3

However, all State-2 target reports shall be updated using alpha=beta=1.0.

3.12.5.6.5 Track initiation.- All target reports which do not correlate with a track file and are track initiation eligible are candidates for starting a new track. Track correlation eligible target reports and target reports from roads (confidence level 000) are discarded; i.e., set to State-0 (S_0), and all other noncorrelating target reports become a track, State-1 (S_1). In order to start a new track m out of n (3 out of 4) detections must occur and the first two must come from high confidence reports which occur in two consecutive scans. The third detection requirement shall be a parameter.

If a radar report has the beacon reinforcement bit set, it shall be immediately raised to a Track State-3. On the next scan the predicted position of the track shall be based upon a State-1, but thereafter shall follow the normal track updating. All target reports which correlated with a track in State-3 and are not beacon reinforced shall be formatted and output to the SCIP. A maintenance switch shall be provided within the SP to inhibit the output of radar-only correlated reports.

3.12.5.6.6. Azimuth synchronization message.- The ASR-9 shall provide 32 azimuth synchronization messages for each 360 degrees rotation of the antenna. The azimuth synchronization messages when received by the ATC computer shall indicate 0 degrees and successive 11.25 degrees intervals and shall be within + .011 seconds (if no antenna synchronization delay in the SCIP is selected) of the actual antenna position. The contractor shall provide for the fixed processing delays of the antenna synchronization messages. The fixed processing delay required to provide accurate antenna synchronization messages shall be site adaption parameter up to 48 ACP's and shall be used to anticipate the transmission of antenna synchronization information. Azimuth synchronization messages shall be transmitted to the SCIP in the CD/ASR-9 search RTQC message format as outlined in appendix III. The number, range, and azimuth position of the antenna synchronization messages shall be under firmware control.

3.12.5.6.7 Output format.- Two complete sets of redundant isolated outputs shall be provided for remoting via modems to two separate remote sites. Each redundant set of isolated outputs shall provide completely dual data paths between the radar site and the dual SCIP's. The add-on capability shall be provided, that by addition of additional modems, each remote site would have completely dual data paths to the radar site. The format of the output data shall be in accordance with that portion of appendix III which deals with the ASR-9 to remote site interface. The contractor shall provide the capability to reformat the surveillance data into any message length, word length and/or bit assignments. This shall be accomplished by changing firmware at a central repair facility (paragraph 3.4.4.1).

3.12.6.- Not used.

3.12.7 Surveillance and Communications Interface Processor (SCIP).- The SCIP shall receive digital data from modems and distribute the data to the collocated ATC computer and, as required to subsystems within the SCIP. Each SCIP shall have the capability to output digital data in serial and/or parallel format. Each SCIP shall provide two isolated serial digital outputs in CD/ASR-9 format and two isolated parallel digital outputs in SRAP/ASR-9 format as described in appendix III. One SCIP, located at the local radar site, shall receive digital data directly from either SP for monitoring.

All ASR-9 messages except weather and correlated radar data shall be transmitted simultaneously from both SCIP's to the collocated ATC computer. The SCIP shall convert the surveillance digital target reports and weather contour digital reports into analog video signals such that they are in suitable form for use as reconstituted video on the specified PPI displays. Physically, the SCIP shall at a minimum incorporate a DP subassembly, distribution amplifier subassembly, switchover unit, and power supplies.

Two SCIP's shall normally be installed at the ATC control facility and one shall normally be installed at the local radar site for use with the maintenance display. Physically, two SCIP's including switchover unit and a distribution amplifier may be housed within a single cabinet provided that each DP and associated power supply is isolated from each other and isolated from the distribution amplifier subassembly and associated dual power supply. Each system shall be wired and capable of operating with 16 control boxes. Sixteen video control boxes shall be furnished per system for use at the indicator site with the 700 aircraft capacity systems and eight video control boxes for the 400 aircraft capacity systems.

The remote modems and SCIP power supplies, including distribution amplifier subassembly, shall be capable of operating from a 120V AC single phase source. This modifies the requirement of paragraph 3.3. If the modem and SCIP power supplies are designed to normally operate from a three phase, four wire AC source, they shall also be capable of operating from 120V AC single phase source.

3.12.7.1 Surveillance and Communications Interface Processor (SCIP) data inputs.- Data input from the local site shall be distributed to both SCIP channels. The add-on capability shall be provided, if completely redundant paths are available between the radar and indicator site, for reconfiguration of the SCIP inputs to input both paths into each SCIP. Selection of the on-line SCIP channel shall be made at the remote site control panels (paragraph 3.16.7). This action shall cause the selected SCIP channel to process the data received from the local site's active channel and shall result in the selected SCIP channel being the source of all analog videos used for the displays at the remote site. There shall be no loss of data to the collocated ATC computer during a SCIP channel switchover. The SCIP shall be able to receive and process all ASR-9 messages of any input format. This shall include messages of different length, word length, and/or bit assignment. This shall be accomplished by changing firmware at a central repair location (paragraph 3.4.4.1). The serial digital input format to the SCIP (as described in appendix III) will remain the same when the ATCBI is replaced by the Mode S system and a beacon report hereafter shall be understood to mean either a report from ATCBI or Mode S System. The inputs to the SCIP shall be:

(a) Surveillance Messages.- The SCIP shall accept beacon, beacon/radar reinforced, radar-only, and correlated radar target reports from the SP in CD/ASR-9 format as defined in appendix III.

(b) Azimuth Synchronization Message.- The SCIP shall accept antenna synchronization messages (paragraph 3.12.5.6.6) from the ASR-9. These messages will be used for the synchronization and generation of synthetic ARP's and ACP's.

(c) Weather Messages.- The SCIP shall accept two-level weather contour messages or six-level weather contour messages from the separate weather channel depending on the weather mode selected. The contractor shall establish the weather message format.

(d) Communication Messages.- The SCIP shall provide termination connections for communication messages between the ARTS/Mode S.

(e) Status Messages.- The status of the ASR-9/Mode S systems shall be accepted by the SCIP for use by the ATC computer.

3.12.7.2 Surveillance and Communications Interface Processor (SCIP) outputs.- The digital SCIP output of surveillance and antenna synchronization data to the collocated ATC computer shall be in CD/ASR-9 (serial output) and/or SRAP/ASR-9 (parallel output) format as outlined in appendix III. However, the SCIP shall have the capability to reformat all CD/ASR-9 (serial output) and/or SRAP/ASR-9 (parallel output) messages as well as the weather data into any message length, word length, and/or bit assignment. This shall be accomplished by changing firmware at a central repair facility (paragraph 3.4.4.1).

Each SCIP shall provide two isolated output serial digital interfaces, each serial digital interface shall consist of three RS-449/RS-422 communication links each operating at 9,600 bits per second. The serial digital interface format output shall be CD/ASR-9 as described in appendix III.

Each SCIP shall provide two isolated output parallel digital interfaces, each parallel digital interface shall transmit 30-bit words plus two bits for parity to Input/Output Processor (part of ARTS-3A). The parallel interface and related interfaces shall be capable of transferring 10,000 words per second. The parallel digital interface format output shall be SRAP/ASR-9 as described in appendix III.

The electrical requirements for parallel digital interface shall be in accordance with the SRAP and Input/Output Processor (IOP) requirement as described in appendix III. Outputs from the SCIP shall be:

(a) Surveillance Messages.- Surveillance data output shall be transmitted in two forms:

(1) Beacon-only, beacon/radar reinforced, and uncorrelated (C&I) radar reports that have not merged with beacon reports shall be transmitted from the SCIP as digital messages to the ATC computer. In addition, the contractor shall provide the ability to select by quality and confidence (maintenance selectable parameter) radar-only target reports that are to be transmitted to the ATC computer on each digital interface (serial or parallel). This maintenance selectable parameter shall include the ability to inhibit all radar-only reports to the ATC computer. All correlated radar reports shall be removed from the ASR-9 data provided to the ATC computer. The SCIP shall reformat all other surveillance data to CD/ASR-9 and SRAP/ASR-9 format as outlined in appendix III.

(2) Surveillance messages shall be displayed in either of four reconstituted analog video modes. The selection of the reconstituted analog video mode shall be a maintenance selectable parameter in the SCIP. The first two reconstituted video modes shall include the following surveillance messages: beacon/radar reinforced, beacon-only, correlated radar reports, and uncorrelated (C&I) radar reports. The first reconstituted video mode (mode 1) shall be displayed with a maximum delay of 1.74 seconds relative to antenna boresight. The second reconstituted video mode (Mode 2) with Mode S System installed and operating with the ASR-9, maximum video delay will increase from 1.74 seconds to 2.1 seconds relative to antenna boresight.

The third and fourth reconstituted videos shall include all of the above mentioned surveillance messages except under certain circumstances correlated radar reports may not be available for display. The third reconstituted video mode (Mode 3) when displaying target reports only (the output of the radar/beacon merge function) shall be displayed with a maximum delay of .59 seconds relative to antenna boresight. The fourth reconstituted video mode (Mode 4), with Mode S System installed video delay will increase from .59 seconds to .89 seconds when displaying target reports only. The selection of delay will be automatic depending on the operational mode at the ASR-9 site. All four modes shall include transmission of radar pretrigger, appropriate analog video data to the beacon decoders (beacon video including framing pulses and mode trigger pulses).

(b) Azimuth Synchronization Data.-

(1) The SCIP shall transmit digital azimuth synchronization information to the ATC computer as defined in paragraph 3.12.5.6.6 in a format specified by appendix III. The contractor shall provide the capability to delay the antenna synchronization information transmitted to the ATC computer. The contractor shall provide a separate maintenance selectable delay (adjustable up to 1,024 ACP's in increments of 1 ACP) for serial and parallel digital interface output.

(2) The SCIP shall generate delayed, synthetic, analog ACP's and ARP's as specified in paragraphs 3.12.7.2.1, 3.12.7.2.4, and 3.12.7.10.

The accuracy of the synthetic ACP's and ARP's, when compared instantaneously over the entire scan to the actual antenna position operating over the service conditions at peak capacity conditions specified by paragraph 3.4.3.2, shall not inhibit the display of any targets. The above conditions shall be met under all video delays specified in paragraph 3.4.3.6.

(c) Weather Messages.- The SCIP shall transmit weather data as follows:

(1) The SCIP shall provide a digital weather output for future use.

(2) Analog reconstituted weather video shall be transmitted to the display subsystem of the terminal control facilities. Two levels of weather shall be transmitted which may be derived from either the two-level weather data or the six-level weather data from the separate weather channel. A manual selection in the control facility shall determine whether two-level or six-level data is used in the facility; if the six-level data is used, an additional manual selection at each controller's position shall determine which two levels of the available six levels shall be displayed at that position. The manual control units, for these selections shall interface with the SCIP.

(d) Communication Messages.- The SCIP shall provide termination connections for communication messages between the ARTS/Mode S.

(e) Status Messages.- The status of the ASR-9/Mode S Systems, including the SCIP, shall be transmitted to the ATC computer in CD/ASR-9 and/or SRAP/ASR-9 format as outlined in appendix III.

3.12.7.2.1 Surveillance and Communications Interface Processor (SCIP) Display Processor (DP) subsystem output characteristics.- The outputs of the DP (per display) shall consist of the following analog signals that are aligned for azimuthal and range coincidence on a PPI display for the selected video mode:

(a) Beacon analog target video including radar and beacon merged reports (single slash);

(b) Correlated target video and uncorrelated target video of selected quality and confidence, including all primary radar target reports; i.e., merged, correlated, and uncorrelated;

(c) Weather video (the two levels of the separate six-level Wx channel selected at each display, or the two-level Wx video from the MTD);

(d) Beacon reply code video including framing pulses and mode pair triggers (regenerated data that is identical to the BTD input specified in paragraph 3.12.5.5);

(e) Reconstituted ARP's and ACP's (4,096); and

(f) Reconsituted radar pretrigger.

Characteristics of the output signals, as measured at the output of the DP across 75 to 100 ohm termination shall be as follows:

Radar and Beacon Analog Videos

Rise Time	*NMT 0.1 microsecond
Decay Time	NMT 0.1 microsecond
Overshoot-undershoot	NMT 10 percent
Droop (200 microsecond pulse)	NMT 10 percent
Duration (isolated target)	Adjustable (See paragraph 3.12.7.2.2)
Amplitude - Adjustable Individually	2 to 6 V positive
Base line reference	0 ± 0.2 VDC
Jitter (referenced to reconstituted pretrigger)	NMT 0.05 microsecond

Radar Pre-Triggers, reconstituted

Rise Time	NMT 0.1 microsecond
Decay Time	NMT 0.1 microsecond
Overshoot-undershoot	NMT 10 percent
Duration	**NLT 1.0, NMT 1.5 microsecond
Amplitude - Adjustable	15V to 40V positive

Beacon Video and Mode Pair Triggers -	Output characteristics shall be the nominal figures described in paragraph 3.12.5.5.
Antenna Azimuth Position Data	
Azimuth change pulses (ACP's)	4,096 pulses per 360 degrees of antenna rotation
Pulses-to-pulse jitter (ACP's)	± 10 percent nominal spacing of ACP's
Azimuth Reference Pulse (ARP)	1 pulse (at magnetic north) per 360 degrees of antenna rotation
Pulse-to-pulse jitter (ARP)	± 20 percent of nominal spacing of ACP's
Logic Level "0"	0 to 0.5 VDC
Logic Level "1"	5.0 ± 1.0 VDC (positive going)
Pulse width, 4,096 ACP/ARP	23 ± 1.0 microsecond
Pulse rise and decay time, 4,096 ACP/ARP	NMT 1.0 microsecond

* NMT Not more than
** NLT Not less than

At the radar site the above outputs may be provided directly to the maintenance display; at the TRACON/TRACAB site these signals are forwarded to distribution amplifiers.

<u>3.12.7.2.2 Target azimuth and range extent</u>.- The beacon and radar target azimuth extent shall be separately maintenance selected (0.1 degrees to 2 degrees) over a 60 nm range, based on range increments not greater than 10 nm. The range extent of the targets shall be maintenance-adjustable between 0.77 to 2.31 useconds in 0.77 useconds steps. Messages representing correlated radar reports, radar and beacon merged reports and target reports of selected quality and confidence shall result in the full range and azimuth extent selected for the radar targets. Messages representing untracked radar targets shall result in an output at a binary fraction of the selected range and azimuth extent (initial design fraction shall be 1/2).

3.12.7.2.3 Beacon target position offset.- The DP shall offset in range by delaying each beacon target video with respect to its corresponding radar target video. This feature shall be maintenance-adjustable between 0 and 2.31 useconds in nominal 0.77 useconds steps.

3.12.7.2.4 Video/azimuth data/trigger alignment.- The DP subsystem shall provide video, azimuth data, trigger alignment such that the system data processing delays (paragraph 3.4.3.6), are properly compensated. All analog video output signals specified in paragraph 3.12.7.2 shall be time aligned for simultaneous overlay viewing on PPI displays specified in paragraph 3.12.7.4. The delay shall be maintenance programmable out to the maximum system data delay and selectable up to 2,048 ACP's as compared to antenna boresight in increments of 1 ACP.

3.12.7.3 Correlated radar and beacon/radar reinforced video.- Digital target reports of correlated and beacon/radar reinforced targets shall be converted to an analog video signal with characteristics as specified in paragraph 3.12.7.2.1. The DP shall provide the means to add/mix uncorrelated radar targets in selected or gated geographical areas as specified in paragraph 3.12.7.4 Correlated video as provided by the DP subsystem is thus a mix of radar only reports that have been (scan-to-scan) correlated by the SP and beacon/radar reinforced (merged) targets. The analog video target is not required to provide a unique distinction between correlated and merged targets.

3.12.7.4 Uncorrelated radar video.- All search radar target reports that remain uncorrelated after comparison of radar only and correlated radar target reports, reference paragraph 3.12.7.1, shall be converted to an analog video signal with characteristics as specified in paragraphs 3.12.7.2.1 and 3.12.7.2.2.

Uncorrelated radar video shall be subject to further filtering based on a selected quality and confidence level which shall be selected for the entire display site by adjustment of a parameter under maintenance control. The DP shall include the capability of providing up to 20 separate range and azimuth gated areas, each selectable in increments of 5 nmi and 8 ACP's or less. These areas shall be site selectable "maps" and shall provide for the display of the uncorrelated video within the gated areas. The output of these gated areas shall be such that the individual display video control boxes may select all correlated and all uncorrelated targets that occur within the selected/mapped geographical area as one of three selectable radar videos. The other two selectable videos shall be: 1) all correlated radar video only (unmapped), and 2) all correlated and uncorrelated video (unmapped) which has been mixed. Based on the the position of the individual controller's radar video selection switch, one of the videos will be provided to the distribution amplifier supplying the display associated with that particular control box.

3.12.7.5 Beacon analog video.- All beacon, and beacon/radar reinforced target reports, reference paragraph 3.12.7.1, shall be converted to an analog video signal with characteristics as specified in paragraph 3.12.7.2.1. This (single slash as viewed on a PPI) analog video target shall have the target position offset capability as described in paragraph 3.12.7.2.3.

<u>3.12.7.6 Weather video</u>.- The digital weather contour reports, paragraph 3.12.7.1, shall be converted to two analog levels. Provision shall be made in the DP subsystem for providing either the two-level weather "map" video as derived from the MTD weather messages to all displays, or the selected levels of the six-level weather video derived from the separate weather channel. Selection of the two-level MTD weather data or the six-level separate weather channel data shall be made for the entire site at the system control panel. Each display video control box (paragraph 3.12.7.12) shall, as a minimum, provide the following indications and/or selection capability for weather:

(1) Source of weather data, two-level or six-level.

(2) When two-level MTD weather is being provided, an indication of weather levels being displayed as low level and high level. The selection of the levels shall be under maintenance control at the local site. For example, if the low level threshold was set for level 2 and the high level threshold set for level 4, the low level weather display would indicate levels 2 and 3 and the high level weather display would indicate levels 4, 5, and 6.

(3) When six-level weather is being provided, an indication of all the levels of weather present within 60 miles of the site are available for display.

(4) When six-level weather is being provided, the following modes shall be available at each control box for selection and display, discrete weather or summation weather:

  (a) Discrete weather shall provide for display of any two weather levels out of the six available. An indication of weather displayed as low and high level shall be provided.

  (b) Summation weather shall display all the weather levels above the selected low level and including the selected low level until reaching the selected high level. All the weather levels above the selected high level and including the selected high level shall be displayed as high level weather. An indication of the weathers being displayed as low and high level shall be provided.

The two levels of weather which have been selected shall be represented by the interior of each zone of light weather being "shaded" with a moderate brightness level for the PPI and the interior of each zone of heavy weather being "shaded" with a brighter level for the PPI. If the two-level MTD weather has been selected for the site, the controller's selection switches shall have no affect on the levels selected for display. The ratio of brightness between light and heavy weather presentation shall be a maintenance adjustment at the DP. The proper two weather videos for a given display shall be mixed and provided to the distribution amplifier providing the input to that display. Complete transfer of weather data on a scan-to-scan basis shall not be required. Complete weather "map" data for both the two-level weather and the six-level weather shall be stored in the video handler. The weather data shall be updated and displayed within the interval of nine scans or less and be available for display as follows: Collection and processing of all weather data shall be completed every six scans or less at the radar site and completely transferred (all 30,720 cells) into the SCIP within three scans or less of completion of collection and processing of weather data.

3.12.7.7 Beacon reply code video. - The display processor subsystem shall provide a converter that shall input the beacon and beacon/radar reinforced surveillance messages (paragraph 3.12.7.1) and convert that data to beacon reply code video that regenerates the original reply code video input as specified in paragraph 3.12.5.5, however, the PRF of the raw beacon reply code video shall not exceed 400. The regenerated video shall allow for a variable delay in the beacon decoders up to 36 micro seconds and be aligned in time to the delayed radar and azimuth data as generated by the display processor subsystem.

3.12.7.7.1 Beacon pretrigger, beacon mode pair trigger.- A combined beacon pretrigger and P1-P3 mode trigger pair signal shall be generated. These triggers shall not exceed 400 Hz PRF, and shall always occur even in the absence of the reply code video. The delay between P1 and P3 shall be set to indicate if Mode 2, 3A, or C video is being reconstituted.

3.12.7.7.2 Beacon reply code video, beacon mode pair triggers, and beacon pretrigger selection. - The beacon reply code, beacon mode pair trigger and beacon pretrigger shall be generated by each SCIP channel in one of two maintenance selectable modes: Mode (1) shall cause all three signals to be multiplexed onto a single output line, at a combined repetition frequency not to exceed 400 Hz. Mode (2) shall cause the beacon pretrigger and beacon mode pair triggers to be multiplexed onto a single line with the beacon reply code video being output on a separate single line. The PRF of the respective signals in Mode (2) shall also not exceed 400 Hz as explained above. The outputs from each SCIP channel shall be input to two distribution control amplifiers. By the use of multiplexing circuitry on the distribution control amplifiers, the on-line SCIP input will be selected from system control. The beacon signals shall be output on two sets of COAX line drivers, for Mode (1) and Mode (2) respectively, with the following characteristics:

BEACON MODE PAIR TRIGGERS, BEACON PRETRIGGER

		Nominal	Extreme
(a)	Amplitude	+25V (Minimum)	+25 to +60V
(b)	Baseline	0.0V	-0.5 to +0.5V
(c)	Width	1.0 us	0.5 to 2.0 us
(d)	Rise Time	0.08 us	0.15 us max
(e)	Fall Time	0.3 us	0.5 us max
(f)	Pulse Spacing (P1 to P3)		
	(1) Mode 2	5 us	4.8 to 5.2 us
	(2) Mode 3/A	8 us	7.8 to 8.2 us
	(3) Mode C	21 us	20.8 to 21.2 us
(g)	Impedance	75 ohms	70 to 80 ohms

REPLY CODE VIDEO

		Nominal	Extreme
(1)	Amplitude	+2 to +6V (variable)	+1.5 to +8V
(2)	Noise	+0.5V	0.0 to +1.0V
(3)	Baseline	0.0V	-1.0 to +1.0V
(4)	SNR	4:1	1.5:1 to 1000:1
(5)	Pulse Duration	0.45 us	0.05 to 2.0 us
(6)	Rise Time	0.1 us	0.05 to 0.2 us
(7)	Fall Time	0.2 us	0.05 to 0.3 us
(8)	Impedance	75 ohms	70 to 80 ohms

3.12.7.8 Video map/gate generator.- The DP subsystem shall generate the video map/gate signals required to provide the selective gating of uncorrelated radar video with correlated video. The device shall be maintenance programmable, with azimuth/range windows, azimuth gates or range gates as required by paragraph 3.12.7.4.

3.12.7.9 Radar pretrigger.- The DP shall provide a radar pretrigger output that is aligned to the delayed radar and delayed beacon video signals. The radar pretrigger shall provide proper alignment to the delayed radar beacon video for use on a standard PPI display. The aligned pretrigger shall occur 100 microseconds ahead of zero range time of delayed radar video. Jitter with respect to zero range time of delayed radar video shall not be more than 0.02 microseconds. The radar pretrigger pulse repetition frequency shall be approximately 1,030 pulses per second, a means shall be provided automatically to check the PRF. Loss of pretrigger shall cause an alarm (paragraph 3.13.5).

3.12.7.10 Azimuth pulse shaper amplifier.- The DP shall input the azimuth synchronization message (paragraph 3.12.7.1(b)) and generate delayed ACP/ARP data that provides for time alignment (paragraph 3.12.7.2.4) of the correlated video, uncorrelated video, beacon video, and weather contour video on PPI displays. Two such sets of isolated ACP/ARP data shall be provided, one set for a PPI maintenance monitor and the second set shall be routed to the distribution amplifier subassembly. A means shall be provided to automatically check that there are 4,096 delayed ACP's and one delayed ARP per antenna scan. Loss of ARP or ACP data shall cause an alarm (paragraph 3.13.5).

3.12.7.11 Azimuth Change Pulse (ACP), Azimuth Reference Pulse (ARP), trigger, and video data distribution amplifier assembly.- The capability to distribute SCIP outputs of ACP, ARP, triggers and video data shall be furnished. This distribution amplifier assembly shall be configured such that the inputs from two DP's are routed through a solid-state switchover unit capable of selecting data from the selected on-line DP. The data output from the distribution amplifier assembly shall be capable of driving sixteen sets by addition of plug in assemblies, each set of outputs shall be as specified in paragraph 3.12.7.2.1. The distribution amplifier assembly may physically be located such that one-half of the assembly (i.e., eight amplifier sets) are with each SCIP provided that functionally the system retains the configuration of dual-channel DP's (P/O SCIP) driving a maximum of sixteen parallel sets of amplifiers. Sixteen amplifier sets shall be provided with the 700 aircraft capacity system and eight amplifier sets shall be provided with the 400 aircraft capacity system. The distribution amplifier assembly shall be isolated from the DP such that a failure or corrective maintenance action on a DP or DP power supplies will not induce a shutdown or failure into any of the distribution amplifiers. The distribution amplifier shall have redundant power supplies. This assembly shall accept the delayed and aligned ACP's, ARP's, triggers, and videos and provide isolation and amplification as required to produce data as specified in paragraph 3.12.7.2 at the end of any length of RG-59, or equal, up to a maximum of 300 feet. Sixteen distribution amplifiers, each with isolated ACP, ARP, trigger, beacon, radar, and weather outputs shall be provided. The input impedance of each module shall be sufficient such that up to two modules can be removed without a change in the outputs signals from the installed distribution amplifier modules. All output amplifiers shall provide sufficient isolation such that improper terminations ranging from short to open circuit, on one or more outputs will not cause damage to the amplifier(s), or be reflected in the outputs of the remaining amplifiers.

3.12.7.12 Display video control boxes.- The display video control boxes shall be similar in construction and operation as the system control panels as described in paragraph 3.16.7, except that use of AC voltages as an input is prohibited. Each control box shall independently select and provide readback of the radar video selected for display (paragraph 3.12.7.4) and the weather available and/or selected for display (paragraph 3.12.7.6).

3.12.7.13 Maintenance Surveillance and Communications Interface Processor (SCIP).- The SCIP normally located at the local radar site, (Maintenance SCIP), shall be identical to the SCIP specified herein with the exception that the following functions are not required at the local radar site. The hardware for these unused function are not required with the maintenance SCIP provided that the SCIP is identical in all other respects and that it can interface with the SP and the maintenance PPI without any other changes or additions:

(a) Distribution subassembly, paragraph 3.12.7.11

(b) Beacon reply code video, paragraph 3.12.7.7

(c) Video map/gate generator, paragraph 3.12.7.8

(d) Display video control boxes, paragraph 3.12.7.12, quantity for the maintenance SCIP is hereby reduced to one each

(e) Switchover unit, paragraph 3.12.7.14

3.12.7.14 Switchover unit.- The switchover unit shall provide the means to select the SCIP outputs (paragraph 3.12.7.2) from the selected on-line SCIP. Additionally, it shall switch the display video control boxes to the selected on-line SCIP. The switchover unit shall provide synchronization data for the standby off-line SCIP such that when switching from one SCIP to the other shall not cause switching transients as viewed on the operational PPIs.

3.13 Performance monitoring.- The ASR-9 shall include a RMS to be used at the ASR facility. The ASR RMS is one of several subsystems of the Remote Maintenance Monitoring System (RMMS) that will be established at each sector office. This ASR RMS will provide the capability to remotely monitor the operational status and key performance parameters of ASR equipment, RBPM monitor output, selected environmental building parameters, engine-generator power status, and site security at these facilities. Monitored parameters and status data will be transmitted periodically over existing landlines/Telco lines via modems to a centrally located data processor, the Maintenance Processor Subsystem (MPS), at the associated sector office. The same data will also be transmitted to the indicator site over landlines and/or Telco lines via modems. The MPS (Specification FAA-E-2698) does not form a part of this specification. The ASR-9 contractor shall provide the modem(s) required for interface at the MPS site. The ASR RMS shall provide the capability to operate the system controls as described in paragraph 3.16 and subparagraphs.

3.13.1 On-line/off-line monitoring.- Each channel of the ASR-9, when on-line shall monitor the performance of all its subsystems, and in a noninterfering basis with the processing of live data, perform sufficient tests to ascertain that the subsystems have not degraded. The standby channel when not in a maintenance status shall perform similar performance monitoring tests as the active channel. When in maintenance status, performance monitoring of the standby channel shall be disabled and no alarms shall be forwarded.

3.13.2 Off-line diagnostics.- Each channel of the ASR-9 shall include, a program or programs, resident in firmware, to exercise each of its digital/analog subsystems and their interfaces. The purpose of this firmware shall be to conduct statistical analysis of the radar/BTD performance. In addition, the diagnostic firmware shall isolate 85 percent of all single failures to the replaceable circuit board and/or module level with a confidence level of at least 90 percent. More detailed diagnostics shall be provided if required to meet the system MTTR. The capability to select and initiate off-line diagnostics and display off-line diagnostic data shall be provided at the RMS and/or MPS and/or the indicator site GFE terminal. Displayed results of diagnostics shall be easily understood without the need to refer to any documentation.

3.13.3 Primary radar Test Target Generator (TTG).- A TTG shall be included with each channel. The TTG shall be under firmware control, and except for the Real Time Quality Control (RTQC), shall be initiated from the performance/status display terminal. The TTG shall derive its RF frequency from the receiver STALO and COHO sources, and shall not require retuning if the receiver frequency is changed. The RF output of the TTG shall be capable of being varied independently in phase and in amplitude. Amplitude adjustments shall be in 1 dB steps within the dynamic range of the A/D converters and shall not cause phase changes. Phase adjustments shall not cause a change in amplitude of the test targets. The TTG shall not generate spurious frequencies that may otherwise interfere with the operation of the receiver. Isolation of the TTG shall be such that it shall not degrade the operation of the receiver regardless of the failure mode of the TTG. The RF level introduced by the TTG (at any point in the receiver channel) when the test target pulse is switched off, shall be 70 dB below the test target amplitude setting or below system noise. The test target generator shall be used to provide test targets for testing system capacity, paragraph 3.4.3.2.

3.13.3.1 Modes of operation.- The following modes of target generation shall be included in the TTG design:

(a) Targets for RTQC - (Active-Standby)

(b) Strobe target - (Maintenance mode).

(c) Ring targets - (Maintenance mode).

(d) Wedge targets - Combination of ring and strobe targets - (Maintenance mode).

(e) Weather targets - (Maintenance mode).

3.13.3.1.1 Real-Time Quality Control (RTQC) target(s)- The Real-Time Quality Control target shall be capable of being generated at an adjustable range and azimuth to a range greater than the useable range of the radar. The target shall be generated independently of the other TTG capabilities and only in the on-line mode. During a 32-scan sequence, the target shall be modulated in phase as required to excite each FIR filter in turn and the measured position shall be displaced within the Surveillance Processor to verify tracking. This displacement of the RTQC shall be added to the measured position following the Surveillance Processor to create a stationary correlated RTQC report at the designated position. The accuracy of the RTQC shall be per paragraphs 3.4.3.3.1 and 3.4.3.3.2. The target shall be adjustable from 1 to 4 CPI's in width.

An uncorrelated RTQC report containing measured parameters shall be generated if detection occurs at one or more of the range-CPI locations where the RTQC target is generated. A correlated RTQC report shall be generated if the uncorrelated RTQC report satisfies the criteria imposed by the Surveillance Processor. Failure to satisfy the criteria shall generate a correlated RTQC alarm (paragraph 3.13.5(c) 17(q)).

3.13.3.1.2 Strobe, ring, and wedge targets.- A population of RF test targets unevenly distributed in azimuth shall be capable of being generated by the test target generator when the channel is in the off-line maintenance mode. By adjustment of the number of targets in range in each azimuth wedge, it shall be possible to generate simultaneous target populations up to 50 percent greater than the specified capacities of the system. The location of strobe, ring, and wedges shall be capable of being positioned in range and azimuth. All targets shall be capable of being modulated in phase to excite at peak amplitude, one (selectable) doppler filter, and (at each azimuth location) adjustable from 1 to 4 CPIs in width. By keyboard entry, the selected population shall also be capable of being changed in range every scan to simulate speeds of 0, 50, or 300 knots and/or in azimuth by one or zero CPI. The test target generator shall provide CW as well as pulse test signals.

3.13.3.1.3 Weather targets.- The TTG shall generate two calibrated simulated weather targets independently adjustable in amplitude in 3dB steps from 0 dBZ to 70 dBZ. The range extent of each simulated weather target shall be adjustable from 1 nm to 20 nm in 1 nm steps. The azimuth extent of the simulated weather shall be adjustable from 10 degrees to 90 degrees in 10 degrees increments. Capability shall be provided to position the center of each weather target anywhere in the radar coverage in increments of 10 degrees and 5 nm. Capability shall be provided to correct the weather levels generated by the test target generator for the radar STC curve. The weather test targets shall be adjustable in width from one to four doppler filters with the capability of varying the center velocity to any doppler filter. The test target generator shall provide the weather signals necessary to test weather capacity. This feature shall be maintenance selectable on/off. A switch shall be provided to allow switching of the weather target to the input of the separate Wx channel.

3.13.4 Performance/status display subsystem.- The performance/status display subsystem shall consist of a direct view display, a keyboard data entry set, a general purpose microprocessor and the interfaces and firmware required to perform the tasks identified in the following paragraphs.

3.13.4.1 Performance/status display terminal and Data Entry Keyboard (DEK).- The following are the minimum requirements for the performance/status display terminal and DEK to be provided by the contractor at the radar site. The performance/status display terminals shall be a medium resolution display, flicker free and capable of displaying ASCII upper and lower case alphanumerics and graphics. The graphic resolution shall be 512 x 390 viewable points. The alphanumeric capability shall be 80 characters per line, with 24 lines. The display terminal shall provide a printer port for connecting an RS-232C printer. The DEK shall be a high quality keyboard with the full 128 ASCII character upper and lower case. At least eight user definable function keys shall also be provided. One performance/status display terminal and DEK shall be provided by the contractor at the radar site. The performance/status display terminal and DEK located at the indicator site will be GFE and consist of the following:

Communications Portable Terminal - Portable computer (WY-50 Display terminal or equivalent with a DB-25 connector having EIA Standard RS-232C pin set).

The contractor shall furnish RS-232C 2400 baud asynchronous modems that will connect the GFE terminal to the RMS via GFE land lines and/or dedicated Telco circuits.

3.13.4.2 Microprocessor.- The microprocessor shall be a general purpose computer with the speed and capacity to perform the specified tasks. The computer shall provide I/O channels to interface with the ASR-9 test equipment, the control and readback channel, an RS232c interface to a portable computer (IBM PC XT) that is GFE, performance/status display terminal and Data Entry Keyboard (DEK), floppy disk drive at the radar site, Radar Beacon Performance Monitor, the MPS via contractor furnished modems of at least 2400 baud and the display and DEK at the indicator site via contractor provided modems of at least 2400 baud. The computer shall be programmed by a high level language compiler which generates machine language appropriate to the selected processor. The microprocessor shall incorporate EIA-RS-232c interface capability, ANSI X3.4 ASCII code compatibility, and IEEE-STD-488 programmable instrumentation capability. A minimum of 20 percent spare memory shall be provided by the contractor.

3.13.5 Firmware requirements.- Firmware requirements for the performance/status display subsystem shall be as follows:

(a) The firmware shall include modules to perform spectrum analysis (128 point FFT) of received targets from stationary objects with the antenna stopped. The object of this program shall be to determine the stability of the ASR-9 System by comparing the amplitude and extent of the sidelobes generated away from the center zero frequency filter. For this program, the interface of the processor shall be with the A/D converters output (paragraph 3.11.6.8) specifically provided for this purpose. The CRT shall display the results of the analysis in form of calibrated spectral lines, with the ordinate in dB and the abscissa in positive and negative frequencies from 0 frequency. It shall be possible to expand the ordinate and abscissa.

(b) Off-line diagnostic executive.- A program shall be provided that integrates all the diagnostic modules into a cohesive software system. It shall display a menu of the diagnostic routines available and shall, by keyboard entry, direct the execution of any program in the menu. Results of the diagnostics shall be interpreted and displayed in plain language.

(c) Performance analysis of the operating channel and standby channel.- A menu of all the performance related programs listed below shall be provided. The capability to select and initiate all of the performance related programs listed below and display of the resultant data shall be provided as requested at either the RMS and/or MPS and/or the indicator GFE terminal. Display of the results of each test shall be in graphical or tabular form and shall be readily interpretable.

1. - Real-time monitoring of C&I, reference paragraph 3.12.4.3.9.

2. - Certification parameters, to be selected by the Government from item (c) of paragraph 3.13.5.

3. - Programmable alarm limits.

4. - Number of correlated reports out of surveillance processing.

5. - Reported range, azimuth, amplitude and dopplers of the first six radar reports output from radar/beacon merge, within a range-azimuth window whose boundaries are adjustable in increments of 1 CPI pair and 1 nmi.

6. - Level of fine grain threshold by filter group/range cell.

7. - Geocensor map threshold by filter group/range cell/azimuth cell.

8. - Number of reports last scan prior to the second adaptive threshold.

9. - Channel A and Channel B status.

10. - Weather Channel Status.

11. - Not used.

12. - A list of the adjustable parameter settings.

13. - Not used.

14. - System Performance

(a) P.S. Voltages
(b) Azimuth tolerance

(c) Transmitter power/AVG
(d) Receiver sensitivity (MDS)
(e) Memory checks
(f) DSP filter performance (if processing by filters)
(g) DSP processor performance (if processing by range segments)
(h) C&I performance
(i) SP performance
(j) Timing checks
(k) Receiver recovery time
(l) Transmitter pulse width
(m) Transmitter pulse spectrum
(n) Noise figure
(o) VSWR
(p) Modems

15. - Beacon performance

(a) Output of ATCBI performance monitor in accordance with FAA-E-2620.
(b) BTD off-line diagnostics (paragraph 3.12.5.5.6.15)

16. - Environmental system performance:

From up to 50 contact closures from a Telco demarc or equivalent. The dry contact closures shall provide either an open circuit or closed circuit.

17. - Alarms

(a) Transmitter Overvoltage
(b) Transmitter Undervoltage
(c) Transmitter Overcurrent
(d) Transmitter Undercurrent
(e) Modulator Overload
(f) Driver Overload
(g) Klystron Overtemperature
(h) Klystron Airflow Failure
(i) Waveguide Pressurization Failure
(j) Power Supply Failure
(k) Main Power Overvoltage
(l) Cabinet Overtemperature
(m) Pedestal Oil Level
(n) Transmitter output power
(o) Azimuth Alarm
(p) Klystron Oil Level/Temperature
(q) Test Target Alarm
(r) Target Overload
(s) Antenna Drive Motor
(t) APG Alarm

(u) Waveguide ARC Detection
(v) BTD Alarms
(w) System performance parameter alarms from paragraph 3.13.5(c)14

18. - System Control Readbacks

Function

(a) Channel A On Line
(b) Channel B On Line
(c) HV On A
(d) HV On B
(e) Channel Alarm A
(f) Channel A Inoperable
(g) Channel Alarm B
(h) Channel B Inoperable
(i) Active Control Box
(j) Antenna Polarization CP
(k) Antenna Polarization LP
(l) WX 2 Levels
(m) WX 6 Levels
(n) WX Level 1-2-3-4-5-6
(o) Antenna Rotation (on/off)

19. - Off-Line Diagnostic Results

(a) Identification of replaceable circuit board failure and/or module.

(d) Test target generator parameters listed below shall be controlled and displayed.

1. Test Target Data

a. Pattern (capacity, ring, strobe, etc.)
b. Minimum range of window
c. Range extent of window
d. Azimuth rate
e. Initial azimuth
f. Range rate (plus stop/start control)
g. Doppler/average PRF
h. Range Vernier (0 or 1/32 nmi)
i. Attenuation
j. Average number of targets generated per scan

2. Weather Target Data

a. Channel under test (2-level/6-level)
b. Polarization

c. Weather level (dBz) d. Azimuth start e. Azimuth extent f. Range start g. Range extent h. Doppler width i. Mean doppler/AV. PRF	Each of two weather areas

3.13.6 Special purpose interface unit.- This unit shall receive 24 bits of I&Q data and a data ready strobe from the A/D converters and an external sample pulse, then provide a sampled and buffered output (24 ports plus data ready strobe) to special test equipment for analyzing spectra, and a buffered output (24 ports plus data ready strobe) to the DSP's toggled data memory. The overall system stability shall be measured with these sampled I&Q outputs. With the antenna spotlighted (fixed) on a stationary specular target, and operating at the normal alternating PRF rate, a 128 point Fourier transform of this target return shall yield a noise floor of at least -81 dB.

3.13.7 Test equipment for performance monitoring.- The contractor shall determine the test equipment complement for performance monitoring, provide the necessary test equipment, rack/cabinet, provide all required special test equipment (paragraph 3.2.15) and provide data documentation as specified in paragraph 3.7.5 for standard test equipment. The contractor is not required to furnish standard test equipment. However, the contractor is required to design the remote performance monitoring subsystem described herein, provide all required interface connectors, wires, sensors, and accessories, unless such wires, sensors, and accessories are normally provided with the standard test equipment and where field installation of such sensors and accessories would not derogate its use; e.g., upset calibration. All required test equipment shall be IEEE-488 compatible.

3.13.8 Test equipment installation/sensors and interfaces.- The contractor shall furnish the test equipment rack and cable interconnections or accessories necessary for operation of the standard or special test equipment. Sensors, readouts, wires, or cables that are required for operation of the standard test equipment to monitor ASR-9 performance shall be provided by the contractor with the exception of those accessories furnished as an integral part of the standard test equipment and intended for installation within the contractor furnished test equipment rack; e.g., AC power cable.

3.13.9 Report processing mode.- Report generating and processing shall be provided and structured in accordance with message formats and interactive procedure specified in ICD-IIC for machine-to-machine interface. The message report format, defined in ICD-IIC, shall be used for interaction using the on-site terminal for command/control and report requests that can be addressed to either the MPS or directly to the ASR equipment.

3.13.9.1 Alarm report.- Alarm processing and reporting shall preempt and interrupt all other report processing modes. An alarm report shall be generated and transmitted to the MPS on the next poll in accordance with ICD-I (NAS-MD-790) as soon as the sampled value of one or more monitored parameters exceeds its alarm threshold limits. Alarm reports shall be processed and transmitted to the MPS as they are detected, on a first-in first-out basis. Alarm reports shall be retained in storage until they are transmitted to and acknowledged by the MPS.

3.13.9.2 Status report.- Status report requirements shall include various types of requests which can be manually initiated by maintenance personnel at the local site and/or MPS site and/or indicator site or automatically by the MPS for either a specific status of a parameter within a group, or a number of groups of monitored functional parameter values or a complete status report consisting of all groups one through eighteen listed under paragraph 3.13.5(c).

3.13.9.3 Interface Control Document (ICD)-IIC development.- The ASR RMS contractor shall be responsible for development of ICD-IIC required in paragraph 3.13.11. The interface and fixed format repertoire to be used by any terminal, portable or fixed, shall be identical while interacting with either the MPS equipment or the RMS equipment. The contractor shall use the ICD-II Work Statement to develop the ICD-IIC.

3.13.9.4 Microprocessor/microcomputer programs.- Complete documentation of all microprocessor/microcomputer programs and firmware program specifications for the RMS shall be provided and delivered in accordance with the contract schedule. Documentation shall include a complete description of the program organization and design, including subprogram description, external data formats, and internal data formats shall be furnished as part of the system design data. The documentation shall provide overall information about the total computer program. The design description shall indicate the partitioning of the functional requirements into logically related subsets which are identified with specific subprograms. For each subprogram, a discussion of performance requirements including estimates of program timing and data storage shall be provided.

3.13.10 Programmable alarm limits.- A programmable alarm threshold value for each variable parameter shall be stored in programmable memory. The programmable alarm thresholds shall be adjustable from the local site terminal, and/or MPS site, and/or the indicator site GFE terminal.

3.13.10.1 Prealarm filtering.- All monitored parameters shall be subjected to the prealarm filtering. When the established alarm threshold for a monitored parameter is detected, this pre-alarm occurrence shall be stored. If two additional prealarm occurrences are detected in different but consecutive scan samples, an alarm report shall be transmitted to the MPS. If three samples are not detected, the number of prealarm occurrences (one or two) for the parameter shall be included in the next scheduled poll (certification data) from the MPS. Prealarm filtering shall also be applicable to monitored parameter(s) whose sampled value has returned to within alarm limits; this case a Return-To-Normal (RTN) alarm report shall be transmitted to the MPS.

3.13.11 Interface documents.- The requirements set forth in the following documents shall be used in the design of the RMS equipment to interface with external subsystems and voice grade private line communications channels.

3.13.11.1 Interface Control Document (ICD), level 1.- External interfaces of equipment shall be designed to meet all electrical interface requirements with regard to interchange of data, timing, and data link control procedures for bit-oriented data link interchanges that are specified in paragraph 6 of ICD-I (NAS-MD-790), dated April 17, 1981.

3.13.11.2 Interface Control Document (ICD), level 2.- The contractor shall submit, for Government approval in accordance with the contract schedule, an ICD for the interface between the RMS and the MPS, and between the RMS and a portable terminal. ICD Level 1, (NAS-MD-790) and applicable ICD Level 1 appendices and standards identified in ICD Level 1 are applicable in their entirety. The document shall be prepared in sufficient detail to completely describe the message formats, structures, interface characteristics, and sequences for interaction with the external terminals and the MPS. ICD-II Work Statement, dated June 28, 1983, shall be used to develop the format and contents of the ASR RMS ICD Level 2 interface document.

3.14 Radio Frequency (RF) plumbing.- Waveguides shall be used throughout the high-power RF path and in both receive paths from the polarizers to the input to the receiver cabinet. The total insertion loss of all components in the transmitter signal path from the RF output tube connector through the waveguide switch shall not exceed 1.2 dB. All components shall have an outside protective coating to increase their resistance to corrosion. Standard WR-284 waveguides shall be used throughout the system. The contractor shall provide the means to pressurize the entire RF system including the antenna. Integrity of the seals shall be such to preclude a leakage rate of more than 0.05 SCFM when pressurized to 2 PSIG.

3.14.1 Waveguide circulator.- The duplexer in each transmitter shall employ a high-power four port ferrite waveguide circulator. The circulator shall isolate the output tube to the extent required to insure optimum spectrum and power output. Performance of the circulator shall be essentially constant over the frequency range of 2.7 to 2.9 GHz. Port connections shall be as follows: Port 1-transmitter, port 2-antenna, and port 3-receiver, port 4-dummy load. The VSWR, as measured in the forward direction between any two adjacent ports, shall not exceed 1.15:1 over the frequency range of 2.7 to 2.9 GHz. The isolation between ports 2 and 1 shall be at least 22 dB over the frequency range of 2.7 to 2.9 GHz. The isolation between ports 1 and 3 shall be at least 20 dB over the frequency range of 2.7 to 2.9 GHz. The isolation, as measured in the reverse direction, between any two adjacent ports not previously specified, shall be at least 18 dB over the frequency range of 2.7 to 2.9 GHz. The isolation, VSWR, and insertion loss requirements shall be met under circuit impedance conditions equal to the operating conditions actually encountered in the radar system. The circulator shall have no moveable or adjustable parts and shall not require forced air or water cooling. The circulator shall be equipped with an external dummy load which is properly matched to the circulator. The dummy load shall be capable of dissipating the full specified transmitter power output without damage for a time duration of 30 seconds. The insertion loss as measured in the forward direction between any two ports shall not exceed 0.6 dB.

3.14.2 Flexible waveguide.- Flexible sections of waveguide shall be provided in the waveguide system as required to prevent mechanical strain.

3.14.3 Directional couplers.- Permanently installed directional couplers shall be provided in each channel as necessary to make the following continuous and independent measurements at the points indicated:

(a) Forward and reverse power between the waveguide switch and circulator.

(b) Main (low beam) receiver sensitivity, TTG, and noise figure with coupler(s) installed between the TR device and circulator.

(c) Same capability as in (b) above for the passive (high beam) receive path. The coupler(s) shall be installed on the antenna side of the TR device.

(d) Same capability as in (b) above for the independent weather channel.

(e) Main (low beam) and passive (high beam) weather channel output couplers installed between TR device and antenna beam switch.

The degree of coupling in all cases listed above shall be appropriate to the intended purpose. Calibration charts indicating the degree of coupling for the 2.7 to 2.9 GHz frequency band shall be permanently recorded on, or adjacent to, all couplers. All directional couplers, except those used for measurement of reverse power, shall have a minimum directivity of 20 dB. Minimum directivity of reverse power couplers shall be 27 dB. The VSWR shall not exceed 1.1:1. Insertion loss shall not exceed 0.2 dB for any coupler over the entire 2.7 to 2.9 GHz band. All couplers, (a) through (d), shall be furnished with Type N coaxial jacks.

3.14.4 Lowpass filter.- A lowpass filter of the absorption type shall be provided for each channel to attenuate radiated harmonic frequencies. The insertion loss from 2.7 to 2.9 GHz shall not exceed 0.15 dB and the VSWR from 2.7 to 2.9 GHz shall not exceed 1.1:1. The attenuation at the 2nd, 3rd, and 4th harmonics shall not be less than 40 dB, 30 dB, and 10 dB, respectively. If pressurization of the filter is required, a permanently installed pressure gauge and a means for replenishing the gas supply shall be provided. The filter shall not require cooling other than convection and radiation. The filter shall affect only the transmit path.

3.14.5 Waveguide switches.- Waveguide switches shall be provided to switch the main and the passive paths between the antenna and the RF dummy loads. The waveguide switches and drive shall be of rugged construction, strong and reliable. Vane-type switching is prohibited. Electrical and mechanical overload protection shall be provided for the waveguide switches. Interlocks shall be incorporated to permit application of HV only when the dummy load or the antenna is connected to the output of the transmitter with the waveguide switch accurately aligned in each of two positions. Positive positioning of the waveguide switch shall be incorporated. The heat dissipated in the RF dummy loads shall not cause mechanical binding of the switches. The waveguide switches shall not require lubrication or routine maintenance more frequently than once yearly. The VSWR of the waveguide switch shall not exceed 1.1:1 over the entire frequency range from 2.7 to 2.9 GHz in either operating position. The cross-coupling attenuation (electrical isolation) of the waveguide switch shall be at least 70 dB between the two operating positions, and the attenuation (insertion loss) of the waveguide switch shall not exceed 0.1 dB in either operating position over the entire frequency range from 2.7 to 2.9 GHz. The waveguide switches shall be installed on the antenna side of the circulator and the passive (high beam) receive coupler so that when the channel is taken off-line both the transmitter and the low beam and high beam receive paths are isolated from the antenna.

3.14.6 Transmitter Radio Frequency (RF) dummy load.- An RF dummy load capable of continuously dissipating transmitter peak RF power without damage or deterioration shall be provided. Dummy load heat rise shall not exceed 15 degrees C above ambient. The RF dummy load shall present a load impedance such that the VSWR shall be constant and not exceed 1.1:1 over the entire frequency range of 2.7 to 2.9 GHz. Liquid or forced air cooling for the dummy load is prohibited. Precautions shall be taken for the prevention of hot spots in the loads and RF leakage shall be held to a minimum.

3.14.6.1 Passive path Radio Frequency (RF) termination.- An appropriate termination for the passive beam RF path shall be provided. This termination shall be applied automatically to the ASR-9 channel in the standby mode.

3.14.7 Waveguides.- All waveguides between the antenna assembly and the equipment in the transmitter/receiver building shall be provided. Tower heights will range between 17 and 77 feet. All supports for waveguides inside the building and on the tower shall be provided. An entrance sealing device shall be provided to seal the building against all weather conditions where waveguide and beacon coaxial cable pass through the wall. Fittings and seals shall be provided to pressurize the entire waveguide run. If any parts require separate pressurization, provisions shall be made to bypass these parts so as to maintain the overall system pressure.

3.15 Range/Azimuth Gate (RAG) generator.- A separate device shall be furnished with each channel to generate programmable azimuth/range windows, azimuth gates, or range gates and perform, as a minimum, other functions as outlined below:

(a) Outputs for antenna beam switching;
(b) Outputs for control of the test target generator; and,
(c) Delayed, gated triggers.

3.15.1 Range/Azimuth Gate (RAG) generator synchronization.- The azimuth and range-dependent functions of the RAG shall be synchronous with the data acquisition system of the signal processor. The range counter shall be capable of being reset to a negative range equivalent to the time between pretrigger and the time of occurrence of an output target at zero range. The least significant bit of the range counter shall be 1/16 nm or less; the maximum count shall be at least equivalent to the range from pretrigger time to 60 nm's after zero range. The azimuth counter shall be a 12 bit counter capable of being reset to any count from zero to 4,095 upon sensing of an ARP from the antenna. Frequency and stability of the range counter shall be as required to insure system performance in accordance with all specified requirements. For example, there shall be no evidence of any switching transients. The azimuth counter output shall be sampled only during radar dead time (time from 60 nm's to the next pretrigger).

3.15.2 Antenna beam switching.- The output of the antenna beam switching portion will be utilized to switch from the high to the low beam antenna. A total of twelve windows shall be provided. Eight of the windows shall begin at zero range and shall adjoin one another in azimuth. The remaining four shall be isolated windows each of which shall have a selectable (programmable) start and stop range, a selectable (programmable) start and stop azimuth, and shall be independent of the adjoining windows in both range and azimuth. The range jitter on the beam switching gate output shall not exceed 50 nanoseconds. To prevent any false alarms from appearing in the output video due to antenna beam switching on an azimuth basis, switching shall occur after the end of the eighth sweep of a CPI and prior to the next PRI.

3.15.3 Test trigger.- The RAG shall provide a delayed, azimuth gated trigger for triggering the test target generator or external test equipment. Delay of the test trigger shall be adjustable between 5 nm prior to zero range, and 60 nm after zero range in 1/16 or less nm increments. Azimuth start shall be adjustable from 0 to 360 degrees; azimuth extent shall be adjustable from 5 degrees up to 360 degrees in increments not to exceed 10 degrees.

3.15.4 Range/Azimuth Gate (RAG) generator general requirements.- The RAG shall be designed to simplify the range/azimuth programming insofar as possible. Under control of a maintenance switch, a video outline of selected gating functions shall be generated for presentation on the maintenance display to assist in setup or in subsequent changes. Unless otherwise specified, range resolution of the RAG shall be 1 nm; azimuth resolution shall be the angle represented by any two consecutive CPI's.

3.16 System control.- In addition to complete local control of the local site equipment, provision shall be made for partial control of the local site equipment and complete control of the remote site equipment from one or more points at the remote site. Status indicators (readback functions) shall be provided to enable operators at the remote site to monitor the condition of the system. Digital data from the ASR RMS shall be capable of partial control of the local site equipment comparable to that control specified for a control panel (box) located at a remote site.

3.16.1 Point of control.- It shall be possible to designate either of two control panels at the remote site or a similar panel at the local site as the point of control for the local site equipment only. Four control panels (boxes) shall be provided; two for installation at the remote site; one for local control of the local site equipment; and, the fourth to be used as an installed spare at the local site. Each control panel shall include momentary switches for taking or relinquishing control of the local site equipment. The transfer of control from any one of the three active control boxes to another shall require the deliberate and simultaneous action of two parties; one depressing the "Release Control" pushbutton on the box in control; the other depressing the "Take Control" pushbutton on the box to which control is to be transferred. An audible signal shall sound at all three active control boxes during the time that the "Release Control" button is depressed. The system status shall remain unchanged during, and subsequent to, a control point transfer until some change is made at the new control point. Indicator lights on each control panel shall indicate whether that panel has, or does not have, control of the system. Control and read back functions for the remote site equipment (SCIP) shall only be contained in the control panels at the remote site.

3.16.2 Local site off-line control.- Placing a local site channel in off-line status shall automatically remove transmitter HV and switch the channel to dummy load. It shall be possible to restore HV to the off-line channel from the designated control point, unless it is in maintenance status as described below. A "Maintenance" switch shall be provided at the local site for each channel. The function of this switch is to transfer complete control of the off-line channel to the local site. The maintenance control shall prevent selection of the off-line channel from the remote site; conversely, operation of the maintenance switch shall have no affect on a channel unless it has first been taken off-line. A channel in maintenance status shall be controlled by controls located on the individual equipment cabinets. The channel in "maintenance" status shall cause the readback function lamp, which indicates that channel as being "inoperable" (paragraph 3.16.6) to light on each panel.

3.16.3 Control signal characteristics.- The status (i.e., state) of each control and readback function shall be maintained in System Control main memory such that this information may be extracted and output to an external terminal, suitably formatted for viewing, via an EIA RS232C compatible serial Digital Communication Link. The contractor will provide all necessary hardware and software to implement this function. Control signal characteristics will be such that momentary power interruptions, loss of power for up to 15 seconds, will not cause a loss of control selections, nor will transients from equipment switchover or electrical power transients as specified in paragraph 3.19.3 cause control functions to be activated.

3.16.4.- Not used.

3.16.5 Readback function.- A readback function shall automatically be initiated as a result of a control being initiated and executed or by some other specified automatic function such as a system alarm or interlock. A readback function and its duration shall be controlled by the duration of, and the status of, the function being monitored. The RS-232C Compatible Serial Line specified in paragraph 3.16.3 shall be terminated at a separate MIL-C-83503A 50 Pin Type Connector (PN M83503/25-24) at the Remote SCIP Cabinet with a cable adapter to a standard RS-232C connector compatible with the remote computer control terminal supplied with the SCIP. Any and all energized readback functions shall appear on all three active control panels.

3.16.6 Common system controls.- Common system controls shall be provided for the following functions. Where the design requires additional common system controls, these additional controls shall be included. Control initiation and readback status display shall be combined into control micro switches. Separate readback status displays do not require the switching function.

	Function	Control	Readback
(a)	Channel A On Line	X	X
(b)	Channel B On Line	X	X
(c)	HV On A	X	X
(d)	HV On B	X	X
(e)	Channel Alarm A	-	X
(f)	Channel A Inoperable	-	X
(g)	Channel Alarm B	-	X
(h)	Channel B Inoperable	-	X
(i)	Release Control	X	X
(j)	Take Control	X	-
(k)	Antenna Polarization CP	X	X
(l)	Antenna Polarization LP	X	X
(m)	Wx 2 Levels Or 6-Level On Line	X	X
(n)	SCIP Channel A Or B On Line*	X	X
(o)	Antenna Rotation (on/off)	X	X
(p)	Spare	X	X

Note: Functions followed by an asterisk (*) shall only have control and readback functions for the site where the control box is located, local for local site only, remote for remote site only.

3.16.7 System control panels.- Four system control panels shall be provided. Two of the panels are for installation at the remote site; of the remaining two panels, one shall be installed at the local site for local control; with the fourth panel installed as a spare at the local site adjacent to the active panel. These panels shall include all switches and indicator lamps required for control and readback functions. A lamp brightness control and a lamp test feature shall also be provided on each panel. The panels shall be designed for flush mounting and shall include a dust cover to protect all wiring, etc. The dimensions of each panel shall not exceed 12 inches in width, 16 inches in height, and 6 inches in depth. All external connections to the panels shall be by means of quick-disconnect jacks and plugs. Each panel shall be complete with a single phase DC power supply to power background and readback status lights. Each power supply shall be individually controlled and shall provide positive DC voltages not to exceed 24V. Provision shall be made for adjusting the power supply output voltage or to otherwise control the voltage across the indicator lamps on the control box from their full rated voltage down to approximately one-third the rated voltage. Regulation and ripple shall be as required to insure normal system operation over the range of service conditions.

3.16.8 Control power supplies.- Two independent modular DC power supplies shall be provided for operation of all system control circuitry other than readback lamps on the control boxes. The control voltage shall be positive, and not in excess of 24V. The two power supplies shall be simultaneously connected to the control circuitry supply bus through disconnect diodes. The output voltage of each power supply shall be sensed, with failure being indicated by a status light. Except for regulation and ripple, the control voltage power supplies shall be in accordance with all requirements of paragraph 3.19.1 and subparagraphs, as well as, all other applicable specification requirements. Regulation and ripple shall be as required to insure normal system operation over the range of the service conditions. Each power supply shall be of sufficient capacity to handle the full system load over the range of service conditions.

3.16.9 Alarm controls.- Alarm controls shall be provided for the system or in each radar channel, as applicable, to report, as a minimum, the alarms specified below. Where the design includes other functions that logically should be reported, those additional alarms shall also be included.

(a) Transmitter Overvoltage*
(b) Transmitter Undervoltage*
(c) Transmitter Overcurrent*
(d) Transmitter Undercurrent*
(e) Modulator Overload*
(f) Driver Overload*
(g) Klystron Overtemperature*
(h) Klystron Airflow Failure*
(i) Waveguide Pressurization Failure
(j) Power Supply Failure
(k) Main Power Overvoltage
(l) Cabinet Overtemperature
(m) Pedestal Oil Level
(n) Transmitter output power
(o) Azimuth Alarm
(p) Klystron Oil Level/Temperature
(q) Test Target Alarm
(r) Target Overload
(s) Antenna Drive Motor
(t) APG Alarm
(u) Waveguide Arc Detection
(v) BTD

In addition, all alarms within a cabinet shall be individually reported within the cabinet. Each alarm indicator shall remain activated until manual reset action is taken at the local site. The alarms on the above list which are followed by an asterisk (*) shall have dual indicator lamps associated with each alarm. The first shall indicate a single fault occurrence and the second shall indicate that a particular alarm has occurred at least three times prior to reset action. When the "three times" alarm indication occurs, that channel shall be automatically switched to "inoperable" status. A red alarm light on the front of each cabinet, visible with the cabinet doors closed, shall indicate any internal alarm.

3.16.9.1 Radar building alarm.- A radar building alarm shall be provided for each channel to provide a special alarm to alert maintenance personnel when an alarm occurs within a radar channel, or when the status of any control would preclude full control of the radar channel from the remote control panel. Each radar channel alarm shall consist of two parallel wired 60 watt lamps installed in suitable red-globe enclosures and located approximately five feet above the floor near the transmitter building door leading to the parking lot.

3.16.10 Spare control circuits.- The control and switching circuitry shall be wired with at least 20 percent spare control circuits (minimum one) of each type used. These spare control circuits are to be completely wired through video selections, switches, relays, and connectors, except for backplane input/output connections. Backplane input/output connections to active modules and spare connectors and cables shall be easily accomplished using standard tools or special tools furnished with the ASR-9.

3.17 Radar Cable Junction Box (RCJB).- A RCJB shall be provided for both the local and remote site. Each of the two radar cable junction boxes shall be the point of demarcation between all of the external landlines, telephone lines, control lines, and the modems. All signals between the local and remote sites shall be routed through the RCJB's.

3.18 Maintenance facilities and documentation.- In addition to built-in test equipment and other maintenance features specified elsewhere in this specification, the facilities specified in subparagraphs hereunder shall be provided.

3.18.1 Instruction books.- The manuscripts for the instruction manuals shall be prepared and furnished in accordance with FAA-D-2494/1 and FAA-D-2494/2. The use of abbreviations on drawings and in text shall be minimized. When used, the abbreviations shall be in accordance with American National Standard Institute (ANSI) Y1.1 (1972). The User's Manual, Operator's Manual, and Program Maintenance Manual shall be furnished as part of the Instruction Book.

3.18.2.- Not used.

3.18.3. Not used.

3.18.4. Not used.

3.18.5 Parts list. This section shall contain a tabulation (reference) of descriptive data on all electrical parts and certain mechanical parts (defined in FAA-D-2494/1 and FAA-D-2494/2) of the equipment. For a single-unit equipment having reference designations not prefixed by a unit number, the tabulation shall be arranged in alphabetical-numerical order of reference designations. For equipment consisting of two or more units, the parts list shall be in subdivisions for each unit, each subdivision consisting of the complete alphabetical series of reference designations within the unit group, arranged in alphabetical-numerical order. The subdivisions shall be in numerical order of the unit groups. This tabulation shall be entitled PARTS LIST. An auxiliary tabulation of manufacturers' names and complete mailing addresses shall be included in the parts list tabulation (paragraph 3.18.6 3rd column).

3.18.6 Parts list tabulation.- All parts shall be fully identified in order to facilitate procurement of replacements without the necessity of correspondence with the contractor or parts manufacturer. The parts list tabulation shall include data covering a description of all replaceable elements of parts normally subject to disassembly, such as capacitors and certain mechanical parts (defined in FAA-D-2494/1 and FAA-D-2494/2) for rotating electrical equipment, and coils and contacts, etc., for electrical contactors and relays. Listed tolerances of parts shall agree with those actually used in production models of the equipment produced by the contractor. The parts list tabulation shall contain the following four columns (explanations are given in parentheses):

1st Column:	REFERENCE DESIGNATION (per FAA-2494/1 and FAA-D-2494/2).
2nd Column:	NAME OF PART AND DESCRIPTION (to be complete for each part). Where Specification FAA-G-1210d, Identification and Cataloging of Replaceable Parts (or superseding document), is made applicable under the contract, the item name of the part shall be determined in accordance therewith.
3rd Column:	MANUFACTURER (Insert the five digit code assigned to the actual manufacturer of the parts used in the equipment, as given in the Federal Supply Code for Manufacturers, Federal Cataloging Handbook H 4-1). Provide a table of manufacturers' names, addresses and supply codes, located at the end of the parts list section. The table shall be in numerical order of the supply code.
4th Column:	MANUFACTURER'S PART NUMBER JAN OR MIL TYPE DESIGNATION AND NATIONAL STOCK NUMBER (The Manufacturer's Part Number is a catalog number, type number or drawing number, by means of which the part is identified. The contractor's part number or drawing number alone will not be sufficient, unless the contractor is also the part manufacturer). (The JAN or MIL TYPE DESIGNATION shall be given in MIL specifications.) (The Federal Stock Numbers or National Stock Numbers obtained during prescreening shall be included in accordance with the following format: FSN XXXX-XXX-XXXX NSN XXXX-XX-XXX-XXXX.)

3.18.7.- Not used.

3.18.8 System grounding.- A common system grounding design shall be used for all units to be delivered under this specification. The grounding design shall contain three discrete systems:

(a) One that bonds together all cabinets and frames which shall be in accordance with applicable parts of paragraph 6 of FAA-STD-019 and paragraphs 4.3.4.4 and 4.5 of FAA-STD-020.

(b) One that connects all signal return wires and shall be in accordance with applicable parts of paragraph 7 of FAA-STD-019, and paragraphs 4.2 and 4.4 of FAA-STD-020.

(c) The AC power grounds shall be in accordance with paragraph 8 of FAA-STD-019 and paragraph 4.6 of FAA-STD-020.

3.18.9 Video switching.- All data selection or switching shall be accomplished by means of solid-state switching devices in lieu of electro-mechanical relays. No adverse effects shall occur at any point in the system as a result of impedance mismatch during switching. Proper termination of all switched functions shall exist for all possible switched states.

3.18.10 Digital recorder output.- The contractor shall provide the add on capability in each system for any interface equipment required to record on a digital recorder the digital input and/or output data, under capacity conditions specified in paragraph 3.4.3.2, from the following points:

(1) C&I input and output simultaneously or the C&I input and simultaneously the point after the radar/beacon merge.

(2) C&I input and simultaneously the SP output.

(3) SP output and simultaneously the remote SCIP input.

(4) Reply-to-Reply beacon data and simultaneously the beacon target detector output or a point after the radar/beacon merge or SP output.

The contractor shall identify a commercially available device as the selected digital recorder, add the selected recorder to the list of standard test equipment (paragraph 3.7.5.a) or as a supplement to that list and provide the documentation specified in paragraph 3.7.5.

3.18.11 Maintenance display.- A display shall be provided to meet the following plan position indicator requirements. The maintenance PPI shall utilize a 16 inch P7 phosphor cathode ray tube with electrostatic focusing and electro-magnetic deflection. Deflection shall be accomplished by fixed yoke. Sweep ranges of 10, 30, and 60 nm's shall be provided and shall be selected by means of a range selector switch. The PPI shall utilize the 4,096 ACP/ARP data directly for azimuth synchronization. Selectable range marks which intensity modulate the sweep and describe circles as the sweep rotates, shall be provided at intervals of 1 and 5 nm's on all sweep ranges up to 60 nm's. When the 1 mile marks are selected, the 1 and 5 mile marks shall be additively mixed so that every fifth range mark is intensified. The range mark intensity control shall vary the range marks from invisibility to the point of blooming on the PPI as adjusted for CRT normal intensity. The range mark generator shall produce range marks to an accuracy of ± 0.25 miles at 60 miles. Sweep linearity shall be such that all of the displayed 5 mile range marks fall within ± 0.1 inch of their correct position on all ranges and throughout the 360 degrees rotation of the sweep. Azimuth accuracy shall be adequate to measure the bearing of known targets to within ± 0.2 degrees, utilizing the compass rose and navigation head. Video bandwidth shall be adequate to measure the bearing of known targets to within ± 0.2 degrees, utilizing the compass rose and navigation head. Video bandwidth shall be adequate for display of radar data from the SCIP, normal log and beacon video. Features shall be incorporated to delay the application of CRT HV to prevent damage to the CRT. The outer case shall be removable and shall incorporate appropriate interlock(s). With the outer case removed, means shall be provided to bypass the interlock circuits. Replacement of AC power and DC power fuses shall be possible without removal of the outer cover(s). The trigger input shall be the aligned system pretrigger and provisions shall be incorporated to delay the sweep and range mark trigger to permit adjustment of display zero radar range. The azimuth shall be properly aligned to insure the corrected azimuth for all videos.

3.18.11.1 Video circuitry.- Five video input circuits shall be provided; one radar video, one for weather video, one for normal log video, one for beacon, and one for raw beacon. It shall be possible to simultaneously display normal log and raw beacon or weather, radar, and beacon video. It shall also be possible to display each video independently. Circuitry shall be provided as required to insure that when a selection of a video or set of videos is made, the selected videos are aligned in range and azimuth. Circuitry shall be provided as required to insure that when log video is selected, the display shall align the log video in range and azimuth. Separate video gain controls, of a range as specified for the range mark intensity control, shall be provided for the beacon video and the selected radar video. Video input impedance shall be 75 ohms, nominal value, and shall be independent of position of the video selector.

3.18.11.2 Controls.- The following front panel controls shall be provided as a minimum:

(a) Focus
(b) Intensity
(c) Beacon video gain
(d) Radar video gain
(e) Unused
(f) Contour weather video gain
(g) Normal log video gain (selectable between channel A/B or Wx channel)
(h) Sweep range selector
(i) Video selector
(j) Range mark selector
(k) Range mark intensity
(l) Navigation head intensity
(m) Radar channel selection for display
(n) On-Off switch.

3.18.11.3 Power supplies.- The maintenance display power supplies shall operate from a 120V AC single phase source. Compliance with paragraphs 3.19.1.4, 3.19.1.5, and 3.19.1.9 is not required; however, the power supplies shall be designed and fabricated as necessary to result in PPI performance as specified over the range of service conditions.

3.18.11.4 Auxiliary features.- An edge lighted 360 degrees compass rose and a rotatable amber navigating head shall be provided. The navigating head shall have one engraved line across the diameter and engraved lines parallel to the centered line.

3.18.11.5 Connections for maintenance display.- Appropriate connections shall be provided for all inputs (including power) for the maintenance display on the back of the maintenance SCIP. Connector covers with captive chains shall be provided for each connector. One complete, durable, prefabricated cable of a length recommended by the contractor and approved by the Government shall be furnished to make all external connections.

3.18.11.6 Connection provisions.- Separate connectors shall be provided and mounted on the display for the following:

(a) Radar video
(b) Raw beacon
(c) Contour weather video
(d) Log normal video
(e) Beacon video
(f) Azimuth position data
(g) Trigger
(h) Power

3.18.11.7 Cart.- A cart shall be provided on which to place a maintenance display (paragraph 3.18.11). The cart shall be equipped with four rubber-tired wheels, free to rotate in any direction for maximum mobility and smooth travel over a concrete or carpet floor. The cart shall be provided with a power cord of sufficient length to reach the convenience outlets of each equipment where it is used. The cart shall be provided with at least two convenience outlets for test equipment. The cart shall hold the display at an optimum angle for viewing by a technician while standing.

3.18.12 Intercommunication system.- A solid-state, multi-station intercommunication system shall be furnished for voice communications between various points at the remote and local sites. Five stations shall be provided with the system; expansion up to a total of ten stations shall be possible. The system shall provide satisfactory voice communications between the local and remote sites. The intercommunication system shall interface with a standard telephone circuit as well as land lines.

3.19 General requirements.- The requirements specified in subparagraphs hereunder apply on a system basis unless otherwise noted, and are in addition to specific equipment requirements contained herein or in other referenced specifications.

3.19.1 Electrical requirements.-

3.19.1.1 Semiconductor terminal identification.- All discrete transistors mounted on printed circuit boards shall have a character "C," representing the collector, on the wiring side of the circuit board in a location approximating the collector terminal. In the case of field-effect semiconductors, the character "D," representing drain, shall be used.

3.19.1.2 Resistor compensated diodes.- The use of resistor compensated semiconductor diode stacks shall not be permitted in circuits in which the peak-to-peak voltage exceeds 1,000V. Instead, single avalanche type silicon rectifiers shall be utilized.

3.19.1.3 Controls.- All circuits shall be so designed that no damage results from the equipment being operated with the operating controls and maintenance adjustments set to any possible combination of settings. No fuses shall blow as a result of actuation of any operational controls. There shall be no noticeable lag between the actuation or adjustment of controls and the effect of the actuation or adjustment except for antenna polarization change and changing of a channel from On-line to Off-line or back again. All controls shall have calibration markings to permit setting to predetermined positions, except where it can be demonstrated to the satisfaction of the Government that this is impractical or unnecessary. Maintenance adjustment controls shall employ small knurled knobs. Where the special nature of a function makes a large knob or screwdriver slot desirable, the use of such controls shall be subject to specific Government approval. Motor driven switches and controls are prohibited except for waveguide switches, motor-driven auto transformers, and antenna polarization controls.

3.19.1.3.1 Location of controls.- Frequently used controls on plug-in modules and cards shall be accessible without removal of the module from its normal position. Controls on units using vertical panel construction shall be on the front surface of the panel of the unit with which the control is associated. Controls for horizontal chassis units shall be mounted on front panels or immediately behind front access panel doors of each unit. All controls shall be mounted so as to minimize the possibility of personnel coming in contact with HV's or components operating at high temperature, or both.

3.19.1.4 Relays.- In addition to the requirements of FAA-G-2100/1, relays utilized in the system (excluding contactors) shall meet the following requirement. A circuit diagram shall be provided on each relay. All chassis-mounted relays shall be of the plug-in type. The number of different relay types used shall be held to an absolute minimum. Each DC relay coil shall have a suitable damping diode or other device to eliminate transients.

3.19.1.5 Regulation.- All power supplies shall be electronically regulated to maintain output voltages within $\pm$ 1 percent as the load is varied from 20 percent less than, to 50 percent more than the normal load, and as the line voltage is varied between service condition limits, with primary power line regulators (if used) in the circuit. The output voltages of these regulated supplies shall be adjustable to any value over a range of $\pm$ 10 percent of the nominal value, and the regulation and ripple specifications shall be met for any and all settings within this range. Power supply output voltage shall not change by more than $\pm$1 percent from the initial setting over the service conditions. The regulation and ripple requirements are minimum requirements, and it shall be the contractor's responsibility to design the equipment with such additional reduction in ripple and improved regulation as is required to meet all specified performance requirements. A separate, independent voltage reference solid-state device shall be used for each regulated power supply voltage, and the regulation of one power supply voltage shall not depend on another power supply voltage for reference.

3.19.1.6 Ripple Voltage.- Ripple voltage is defined as the peak-to-peak value of a simple or complex waveform consisting of power line frequency components and harmonics thereof, and/or synchronous or repetitive nonsynchronous transients. The maximum permissible level of ripple voltage on any power supply is the responsibility of the contractor and shall be specified as required to meet all equipment performance characteristics specified herein.

3.19.1.7 Power supply protection.- As specified in paragraph 3.19.1.5, for loads up to 1.5 times the normal load, power supplies shall maintain an essentially constant voltage characteristic. For any continuous load in excess of 1.5 times the normal load, up to and including a dead short, current limiting shall occur such that no damage is incurred by any power supply parts; no fuses are blown or circuit breakers are tripped; and the power supply voltage returns to normal when the normal load is restored.

3.19.1.8 Load protection.- Crowbar type overvoltage protection shall be provided on all power supplies used to drive voltage-critical devices. There shall be no transients or surges at turn-on, or upon restoration of power, following a power loss that could cause equipment failures or cause fuses to blow or circuit breakers to trip. The equipment shall automatically disconnect the voltage from circuits which would be damaged by loss of, or deviation from, its normal value of bias voltage. Load point regulation shall be employed as required to insure that voltages as measured at the load are within the nominal range for driven circuitry.

3.19.1.9 Power supply indicators.- Each circuit protected by a fuse or circuit breaker shall have an indicator lamp which shall provide positive indication when the fuse (or circuit breaker) is open. Neon indicator lamps shall be used where possible. Indicator lamps shall be uniformly located with respect to their associated fuses or circuit breakers or they may be an integral part of the fuse holder assembly. Each power supply shall also have an integral indicator lamp to show when the power supply itself fails, as contrasted to a fault which would trip the breaker or blow a fuse.

3.19.1.10 Power supply metering.- Meters and associated switches for use in measuring all power supply output voltages and currents shall be furnished. The preferred location of these switches is on the front panels of the cabinet containing the circuits to be metered. They may be located elsewhere provided they are visible with the cabinet doors opened. No metering is required where the contractor and the Government mutually agree that voltage test points would be sufficient or where circuitry is unduly complicated. Each meter shall be provided with a replaceable card insert mounted near the meter to designate the proper reading of each associated switch position. Operation of meter selector switches shall not interfere with proper system performance. When shunts are used in conjunction with meters to read currents, specially specified meter movements over and above MIL specification requirements shall be employed with the resistance of the meter movement held to close tolerances to permit a 3 percent overall accuracy in true load current measurements. Meter calibration test points shall be provided across each meter.

3.19.2 Electromagnetic interference and susceptibility.- The equipment shall be designed and constructed to meet the interference and susceptibility requirements of MIL-STD-461 and MIL-STD-462 for Class A3 equipment. The contractor shall prepare and submit, in accordance with the contract schedule, an interference control plan detailing the contractor's intent and methods in satisfying the applicable requirements of the interference standards. The plan shall be in accordance with paragraph 4.2 of MIL-STD-461.

3.19.3 Surge protection.- Protective devices, which shall be submitted to the Government for approval, shall be provided as necessary to prevent damage to the equipment from surges on either the AC power lines, or the remoting lines. The protective devices shall be capable of limiting initial spikes as might result from nearby lightning strikes to a value that will not damage any equipment. The protective devices shall be capable of withstanding repeated surges without damage or change in operating characteristics. The protective devices shall be in accordance with the applicable parts of paragraph 3 of FAA-STD-019 and paragraph 3 of FAA-STD-020.

3.19.4 Commercially available equipment.- The use of commercially available equipment to perform certain listed functions herein is acceptable provided that the following requirements are satisfied. Prior Government approval must be granted before a commercial device can be used for these listed functions:

(a) Intercommunication system
(b) Modems
(c) Standard test equipment
(d) Remote monitoring subsystem
(e) SCIP's

The request for Government approval for use of commercially available equipment in a listed function shall delineate how the following requirements will be met:

(f) The proposed commercially available device has been available for at least two years.

(g) The reliability and maintainability program requirements (paragraph 3.6 et.al.) are not derogated.

(h) Documentation requirements as specified for instruction books, software hardware, and data for spare parts peculiar will be satisfied.

(i) Identify the affected general requirements that need be waived in this equipment specification or FAA-G-2100.

(j) Identify a second source, if available, for the proposed commercial equipment or an alternate source for an equivalent equipment.

3.20 Packaging and construction.- The basic packaging concept of the equipment shall be small plug-in modules and printed circuit boards to the extent practicable, mounted in standard cabinets (paragraph 3.20.1). The structural strength and rigidity of equipment units and cabinets shall be such that normal handling in loading, shipping, unloading, and setting into position for installation, as well as movement over-the-road with the equipment installed in transportable buildings, will not result in any mechanical damage, or in any way degrade the operation, appearance or maintainability of the equipment. At least 10 percent of the front panel of each equipment cabinet, together with the interior cabinet space behind it, shall be left unused. Blank panels shall be furnished and installed for any unused space.

3.20.1 Cabinet design.- Equipment cabinets, except as noted in paragraph 3.10.1, shall be of uniform size, not to exceed 80 inches in height, 30 inches in depth, and 36 inches in width. All cabinets shall be of high quality, sturdy construction, accurately and carefully fabricated, with facilities for leveling (or shimming) and fastening to the floor. Ventilation air shall enter near the bottom and exit from the cabinet top, with the air exit screened or otherwise protected to prevent small objects from falling into the cabinet. This exit shall be suitable for connection to a duct for venting in accordance with paragraph 3.20.2. Cables may be routed directly through the interconnecting walls by means of appropriate feed-throughs and/or connectors, provided that such interconnections comply with the requirements of paragraph 3.19.2. Access to the cabinet interior for normal maintenance shall be from the front only, with full width, latching access doors extending from near the top of the cabinet down to the air inlet. Rear access is permitted only for the purpose of installation, replacement, or repair of interconnecting cables or wires. Access doors shall be mounted by slip-pin hinges so that the doors may be easily removed. The hinges shall be adjustable, and secured to the cabinets by means of screws or nuts and bolts. All cable and waveguide shall enter the cabinets near the top.. Panels, chassis and modules/card bins shall be adequately supported within the cabinets and of a size and weight as will permit removal and replacement by one technician. Convenience outlets (1-3.6.4, FAA-G-2100/1) shall be provided on the lower front of each cabinet.

3.20.1.1 Overheat warning devices.- As a minimum, each cabinet shall be provided with a temperature sensor located just inside the air exhaust outlet. Sensing of a temperature rise in excess of the design limit (normally the maximum ambient temperature plus the cabinet rise above ambient permitted by FAA-G-2100/1) shall be indicated by a warning light conspicuously located on the cabinet, as well as by a channel fault light. Additional temperature sensors and air flow switches shall be provided as necessary to protect the system from damage.

3.20.1.2 Cabinet illumination.- Shielded lights for general illumination of the cabinet interiors shall be provided. These lights shall be turned on by opening of the cabinet access door, and turned off by closing of the door. With the door open, manual control of the lights shall also be possible. If meters, controls, test points, etc., are visible or accessible with the access doors closed, additional lighting shall be provided as is required to make them readily visible with the room lights turned off. Manual control of these lights shall be provided.

3.20.1.3 Front panel connectors and cables.- Front panel connectors and cables shall be limited to those required for testing.

3.20.1.4 Shorting rods.- Adequately insulated shorting rods with a connecting grounding strap permanently affixed to good cabinet grounds shall be provided and installed on hooks inside the doors of all cabinets which contain voltages (other than primary AC power) in excess of 150V to enable maintenance personnel to ground all points which are potentially hazardous before performing equipment maintenance. Caution plates shall be installed in appropriate locations to remind maintenance personnel to utilize the shorting rods before performing any maintenance on the equipment.

3.20.1.5 Transmitter cabinet components.- Large components in the transmitter modulator and HV power supply portions of the equipment may be mounted on a horizontal chassis, mounted horizontally at floor level, or mounted on cabinet walls provided they are adequately supported and all mounting fasteners, terminals, and associated wiring for such components are easily accessible for maintenance testing and repair, through the front access door, without requiring removal of the chassis.

3.20.1.6 Indicator light lens color.- Color for equipment cabinet indicator light lenses shall be selected from the tabulation below for the functions listed in lieu of those specified in FAA-G-2100, paragraphs 1-3.16.5.2 and 1-3.16.5.2.1.

Color	Function
Red	Indicator for alarm controls, ref. paragraph 3.16.10
Green	Filament/Heater Voltage, AC Line and DC power supply voltages
White	Local - Remote Control (Light ON for local)
Amber	Bypass (Light ON when function is bypassed)
Clear (Neon bulb)	AC Line Power

3.20.2 Ventilation and cooling equipment.- All blowers, vents and other cooling equipment necessary for the proper operation of the equipment over the range of the service conditions (paragraph 3.3.2) shall be provided. Each cabinet shall contain its own blower system, and at the local site shall include ducts which shall be used to vent the exhaust to the transmitter vent system described in paragraph 3.10.3.2. The input to the transmitter exhaust system shall be such that the air is returned to the room or exhausted to the outside as controlled by the transmitter exhaust system. With the access doors of any or all cabinets open, for up to eight hours, the equipment shall not overheat, develop hot spots, or become unstable in operation.

3.20.2.1 Ventilation blowers.- All primary cabinet blowers shall be three phase, continuous duty type. Small auxiliary blower motors, as for example might be employed for moving air directly through the heat sink of a power supply, may be single phase provided, however, that they do not exceed 0.1 horsepower in capacity. All blower motors shall be equipped with sealed, permanently lubricated bearings.

3.20.3 Modular concept.- The configuration of the modular assemblies shall be one of the following:

(a) Standard rack mounting slide-out drawers or chassis. Drawer slides shall be heavy-duty locking type to permit locking the drawer or chassis in either the normal closed or extended position. Printed circuit cards or modules shall be mounted vertically in the drawers/chassis.

(b) Standard rack mounting assemblies with shelf mounted modules that plug into a front panel/chassis assembly. Printed circuit cards or modules shall be mounted vertically.

3.20.3.1 Plug-in modules.- Plug-in modules and plug-in PC card modules shall be designed for mounting in card bins or module bins. Plug-in modules shall have a metal chassis or other suitable framework to provide a solid part mounting structure, with adequate protection for printed wiring and small parts when inserting, removing, or during handling of, modules after removal from the equipment.

(a) Module Removal and Insertion Damage.- All equipment shall be designed to enable the removal and insertion of modules and PC cards, without causing or inducing damage to any equipment external to the module or PC card.

(b) Induced Transients.- A means shall be provided to enable the removal or insertion of any off-line module or printed circuit card, without generating any logic or electronic disturbance that may affect the on-line system operation.

3.20.3.2 Mounting.- Plug-in modules and PC cards shall be mounted side-by-side, bookcase style, in an assembly, and shall be equipped with chassis guide strips or rails (or both) and mating connectors, as are necessary to ensure positive alignment of the module connector with its mating receptacle. Quick acting fasteners shall securely lock front-panel type of plug-in modules and cards in their operating position when the average withdrawal force is less than 10 pounds.

3.20.3.3 Connectors.- The connector receptacles shall contain a polarizing key and the key location shall be different for each different type of module and card. All assemblies of the same type shall have the same polarizing key location to ensure insertion of the proper type. The keying method shall not reduce the number of connector pins. Mating connectors shall be designed for repeated use with the modules and cards to ensure long-term reliable performance, and with suitable mountings to permit insertion without jamming or otherwise damaging the connector elements.

3.20.3.4 Module/card extenders.- A module/card "extender" shall be supplied for each type of module/card. An extender consists of a printed circuit board (not keyed in order to permit insertion into any connector) provided with printed circuitry and coaxial leads to extend all plug input points across the board to a receptacle on the opposite end, into which receptacle a removed assembly can be plugged. The extender thus provides an accessible active operating position for any assembly normally inaccessible for maintenance and test while within the bin. Provisions shall be included to prevent a module or card from being improperly oriented (for example, a PC card reversed) when the extender is in use. No derogation of system or module performance shall result from proper use of the extenders.

3.20.3.5 Solderless wrapped electrical connections.- Solderless wrapped electrical connections may be used with appropriately designed wrapposts (terminals). Solderless wrapped electrical connections shall be in accordance with MIL-STD-1130. Copper conductors shall be annealed, oxygen-free high conductivity solid copper wire as defined in ASTM-B224. For AWG-28 and smaller wire, the following modifications to MIL-STD-1130 apply:

(a) Add AWG-28, AWG-29, and AWG-30 to paragraph 5.1.1.

(b) Add following to table I of paragraph 5.1.1.2:

Size AWG	Diameter Inches	Elongation Min/Max Percent
28	.0126	12/33
29	.0113	12/33
30	.0100	12/33

(c) After fifth sentence of paragraph 5.1.2, add: For AWG-28, AWG-29, and AWG-30 wire, the stripping force shall be .5 to 2.5 pounds.

(d) Add following to table II of paragraph 5.3.2:

Size AWG	Diameter Inches	Minimum No. Turns (A) Modified	Minimum No. Turns (B) Conventional
28	.0126	7 stripped + 1/2 insulated	7 stripped
29	.0113	7 stripped + 1/2 insulated	7 stripped

(e) Add following to table III of paragraph 5.6.1:

Size AWG	Diameter Inches	Minimum Strip Force (pounds)
28	.0126	4
29	.0113	3 1/2
30	.0100	3

(f) Add following to table IV of paragraph 5.6.3:

Size AWG	Wire Wrap Diameter Inches	Current to be Used (AMPS)
28	.0126	2.0
29	.0113	1.5
30	.0100	1.0

3.20.3.6 Electrical filters.- Electrical filters, except radio interference filters, shall conform to MIL-F-39025. Nonstandard cases and mountings, designated 'YY' and 'ZZ' shall not be used. Radio interference filters shall conform to MIL-F-15733.

3.20.3.7 Ferrous materials.- When ferrous materials are used with prior approval of the Government, they shall be in accordance with MIL-STD-454, Requirement 15.

3.20.3.8 Wire identification.- Color coding is not required for wires used in backplane wiring. This modifies paragraph 1-3.10.6 of FAA-G-2100/1.

3.20.3.9 Printed circuit cards.- Single layer printed circuit cards shall be in accordance with the requirements of Specification FAA-G-2100/4. Multilayer printed wiring boards shall be in accordance with the requirements of Specification MIL-P-55640 in addition to FAA-G-2100/4. Screwdriver adjustments required for alignment shall be held to a minimum; however, when required, such adjustments shall be made on the circuit card. All cards shall use a common position on the connectors for the power supply and ground leads.

3.20.3.9.1 Nonaxial-leaded parts.- Nonaxial-leaded parts (excluding transistors and integrated circuits) shall be mounted against or as close as possible to the printed circuit board.

3.20.3.9.2 Air filters.- Where disposable air filters are used, they shall be in accordance with Federal Specification F-F-310. This modifies paragraph 3.9.4 of FAA-G-2100/1. The air filters shall be removable from the outside (exterior) of the equipment cabinets without the necessity of opening access doors or moving any other equipment cabinets.

3.20.3.10 Transformers.- A three phase power transformer may be used where isolation of the three phase power line is required for use within the transmitter cabinet. This transformer shall meet the requirements of MIL-T-27, Class R, Life Expectancy X, but shall be excluded from meeting sealing, immersion, vibration, and shock requirements of Grade 4 units. Material used in construction of the transformer shall meet the design requirements of MIL-T-27, Grade 4; however, air cooled open winding construction may be used provided that the transformer is physically located within the transmitter cabinet and a metal protective cover is provided. All other transformers shall meet the following requirements.

3.20.3.10.1 Transformers, inductors, and coils.- Transformers, inductors, and coils shall be in accordance with MIL-STD-454, Requirement 14. In lieu of tables 14-I and 14-II of Requirement 14, the table below applies. Transformers and inductors used for audio, power and high power pulse shall have solder-type or screw terminals (life test and corona test not required unless specifically required in the detail equipment specification). Single phase AC line operated transformers shall not have more than three secondary windings and one centertap.

SPECIFICATION	GRADE	TEMPERATURE CLASS
MIL-T-27[1]	4 or 5	R
MIL-T-39013	4 or 5	R
MIL-T-21038[1]	4 or 5	R
MIL-T-39026	6 or 7	R
MIL-C-15305	1	B
MIL-C-39010	-	B

[1]Life expectancy X, MIL-T-27

3.20.3.11 Sockets for microelectronic devices.- All semiconductor and integrated circuit components shall be mounted as specified in paragraph 3-3.2 of FAA-G-2100/3 and paragraph 3-3.1(C) of FAA-G-2100/5 respectively, except that other mounting techniques (e.g., sockets) will be permitted in association with wire wrapped integrated circuit panels. In the event such deviation is necessary, the contractor shall obtain specific Government approval for the mounting technique and/or sockets with reliability data to support such use.

3.20.3.12 Parts and material.- Parts and material shall be selected in accordance with Specifications FAA-G-2100/1, /3, /4, and /5. For the purpose of this specification, parts and material specifically called out herein and in the other referenced specifications are considered 'standard.' All parts and material not so called out, specified as requiring approval, or specified as not to be used, are considered "nonstandard," and require Government approval for design and use in the equipment. The contractor shall not order or manufacture such nonstandard parts or materials until he has complied with the requirements of subparagraphs hereunder and received written approval from the Contracting Officer or his designated Technical Representative for usage in the equipment. This modifies paragraph 1-3.14.8 of Specification FAA-G-2100/1.

3.20.3.12.1 Data requirements.- To obtain approval of a nonstandard part or material, the contractor shall submit a Nonstandard Part Approval Request (NPAR) to the FAA Contracting Officer. The NPAR shall include a completed DD Form 2052, Nonstandard Part Approval Request form, containing all technical data necessary to determine whether usage of the nonstandard part or material is justifiable from an engineering standpoint.

3.20.3.12.2 General.-

(a) A NPAR form must be completed for each nonstandard item and all requests shall be numbered sequentially. A separate NPAR is required for each different application of any part, whether on the same or different subassemblies.

(b) Standard parts meet the requirements of applicable specifications. Nonstandard parts must be of equal or better performance characteristics and reliability.

3.20.3.12.3 Requirements of Nonstandard Part Approval Request (NPAR) form.-

(a) The NPAR submittal to be used by contractors-subcontractors is shown in figure A. These NPAR forms are to be completed by the contractors-subcontractors with two copies submitted to the Contracting Officer. Subcontractors shall submit their NPAR forms through their contractors. The contractor shall include contractual coverage in all of their subcontracts to insure that the subcontractors comply with this specification to the same extent as the prime contractor.

(b) Part I of the NPAR form shall be completed in full. The information thereon shall be typed or printed legibly to permit the reproduction of additional copies by normal methods.

3.20.3.12.4 Preparation of the Nonstandard Part Approval Request (NPAR) form.-

(a) All items in Part I on the NPAR form must be completed. Those items that may not be applicable shall contain the letters "NA" (not applicable) or "none."

FIGURE A

NONSTANDARD PART APPROVAL REQUEST

LOG NUMBER

NOTE: See instructions for preparation on reverse side.

PART I - CONTRACTOR INPUT

1. PRIME CONTRACT NUMBER
2. CONTRACTOR
3. EQUIPMENT/SYSTEM/SUBSYSTEM
3A. DATE OF INVITATION FOR BID *(RFP,RFQ)*
4. PART PROCUREMENT DOCUMENT NUMBER *(If applicable)*
5. PART NUMBER
6. FSCM
7. QUANTITY

8. VENDOR	9. VENDOR PART NUMBER	10. FSCM

11. EVALUATION REQUESTED *("X" appropriate box)*
☐ PART ☐ PART AND DOCUMENT ☐ DOCUMENT ONLY

11A. LOG NO. FOR PART PREVIOUSLY SUBMITTED ON THIS CONTRACT

12. DESCRIPTION CODE

13. ALTERNATE OR SUPPLEMENTAL DESCRIPTION

14. REASON FOR USE OF NONSTANDARD PART *(Compare part with nearest equivalent standard) (Continue on reverse side, if necessary)*

REPLY NEEDED BY	PRINTED OR TYPED NAME OF CONTRACTOR REPRESENTATIVE	DATE	PHONE NO. *(Include Area Code)*

PART II - RECOMMENDATION

DATE IN	DUE DATE	EVAL. OPI	MPCAG MANAGER	SERVICE ACTY	ENGINEERING ITEM CODE

15. APPROVAL	16. DISAPPROVAL	17. NO RECOMMENDATION	18. DOCUMENT EVALUATION
☐ WITHOUT LIMITATION	☐ REPLACE WITH MIL PART *(Complete blks 19A thru D)*	☐ INSUFFICIENT INFORMATION *(See comments, block 23)*	☐ ADEQUATE
☐ LIMITED APPLICATION *(Complete blks 19A-E or 20A-C)*	☐ SPEC BEING PREPARED *(Complete blks. 19A thru E)*		☐ INADEQUATE *(See comments block 23)*
☐ OTHER LIMITATIONS *(See comments, block 23)*	☐ COMMERCIAL REPLACEMENT *(Complete blks 20A thru C)*	☐ NOT UNDER THIS REVIEW AGENCY	☐ NO DOCUMENT

19A. REPLACE WITH *(Enter Mil. Spec., Fed. Spec. or Gov't approved Std)*
20A. REPLACE WITH COMMERCIAL PART/TYPE/STYLE NO.
19B. MIL PART/TYPE/STYLE NO.
19C. FSCM
20B. MANUFACTURER
20C. FSCM
19D. QPL AVAILABLE
☐ YES ☐ NO ☐ N.A.
19E. DATE MIL SPEC AVAILABLE
21. REPLACEMENT DESCRIPTION CODE *(As applicable to blks 19B or 20A)*
22. PART RECOMMENDED IN BLOCK 19B OR 20A IS: ☐ INTERCHANGEABLE ☐ SUBSTITUTE ☐ REPLACEMENT
23. COMMENTS *(Continue on reverse side, if necessary)*

ADP INPUT	
A	
E	
F	

EVALUATOR AND DATE

QPL MONITOR AND DATE

PART III - PROCURING ACTIVITY DECISION *("X" only one box)*

☐ 24A. IMPLEMENT RECOMMENDATION ☐ 24B. APPROVE PART ☐ 24C. DISAPPROVE PART

25. COMMENTS *(Continue on reverse side, if necessary)*

PROCURING ACTIVITY REPRESENTATIVE *(Typed or printed name)*	SIGNATURE OF REPRESENTATIVE	DATE

DD FORM 1 FEB 76 2052 EDITION OF 1 APR 77 MAY BE USED UNTIL EXHAUSTED

(b) Complete preparation instructions are on the reverse side of the DD Form 2052. When completing Block 14 on the form, compare the nonstandard part to the standard part whose characteristics are nearest to those required for the application. Include:

(1) If size and weight are the reasons for selection of the nonstandard part, give detailed advantages over the standard part.

(2) If electrical or mechanical characteristics are the reason for selection of the nonstandard part, give detailed performance degradation, in terms of overall equipment performance, that would result if a standard part were used.

(3) If reliability is the reason for selection of a nonstandard part, provide supporting data.

(4) If undue delay in production is the reason for selection of a nonstandard part, give delivery dates and sources of both the standard part and nonstandard part.

(5) Supplemental data such as existing control drawings, specifications, vendor data sheets, and other pertinent data need not be furnished for nonstandard parts covered by documents listed in the Department of Defense Index of Specifications and Standards (DODISS).

(6) In cases where the nonstandard is a process instead of part, similar detailed information shall be supplied. Step-by-step process flow charts shall be submitted, in addition to specific process specifications which apply to the process steps that will be changed to nonstandard.

(7) Failure rate data (to be completed by parts reliability engineer). This data shall include as a minimum, the failure rate per nonstandard item, the failure rate per standard item, number of items, estimated total failure rate impact and failure rate source. Failure rate sources must be identified as to MIL-HDBK, GIDEP, vendor, or subcontractor data based on test or field experience. In those cases where the information on failure rate and life cycle is not available at the time of submittal, it shall be added by revision.

(8) The subcontractor shall complete, sign, and forward the NPAR with all attachments to the contractor. The contractor shall complete, sign, and forward the NPAR with all attachments to the FAA Contracting Officer. All signatures appearing in the signature block shall be in black ink to facilitate reproduction.

3.20.3.12.5 Military parts control advisory group.- An Interagency Parts Control Agreement between the Department of Transportation/FAA and the Defense Logistics Agency (DLA) has been implemented. This agreement provides for a working arrangement and procedures that enables the DLA to act as advisor to FAA and their contractors in parts selection and use.

3.20.3.12.6 Procedures.- In addition to the above requirements, the following shall also apply:

(a) The Military Parts Control Advisory Groups (MPCAG) located at the Defense Electronics Supply Center (DESC) and the Defense Industrial Supply Center (DISC) are authorized to review and recommend disposition of parts requests submitted by contractors and act as advisor to FAA facilities, Logistics and Research Services in parts selection and use.

(b) The FAA's Contracting Officer or his designated technical representative shall be responsible for final approval and/or disposition of parts requests submitted by its contractors and or all formal contact with contractors.

(c) Requests for information and the submittal of NPAR's will depend upon the type of part or material involved.

(1) Electrical or electronic parts as described in paragraph 6.4b of MIL-STD-965. One copy to FAA Contracting Officer and one copy to:

Commander
Defense Electronics Supply Center
ATTN: DESC-EPA
Dayton, Ohio 45444

Telephone number for general inquires
(513) 296-6368

(2) Mechanical parts as described in paragraph 6.4.a of MIL-STD-965. One copy to FAA Contracting Officer and one copy to:

Commander
Defense Industrial Supply Center
ATTN: DISC-ESM
Philadelphia, Pennsylvania 19111

Telephone number for general inquires:
(215) 697-4195/4395/3969

(d) NPAR Form numbering. Each FAA contract will be assigned a five-digit contract code by the DESC MPCAG. Contractors must call the DESC

MPCAG to obtain this code prior to the submission of any NPAR's. The log number of each NPAR is their contract code followed by the appropriate Federal Supply Class (FSC) and a sequentially assigned four-digit number by the contract.

Example: Log No. ____________ - 5905 - 0005
Contract Code / FSC / Index No.

3.20.4 Exterior metallic surfaces.- In lieu of the finish system described in Paragraph 1-3.8.2 of FAA-2100/1b, the following finish system may be used:

(a) Chemical film per MIL-C-5541, Class 1A.

(b) Epoxy polyamide primer per MIL-P-23377, Type 1, thickness 0.0006 to 0.0009 inches.

(c) Alkyd enamel (baking) per Federal Specification TT-E-529 or equivalent, color brown, color number 20372 per Federal Standard 595, thickness 0.0009 to 0.0013 inches (applicable to smooth surface only, - textured surfaces vary in thickness).

3.21 Receive only Wx channel.- The receiver only Wx channel shall include but not be limited to two tuneable bandpass filters (one for each transmit channel), receiver STC, antenna RF pattern switch, RF amplifier, mixer, pre-amplifier, IF amplifier, two 12 bit A/D converters (I&Q), Wx channel processor, two weather data mode select units, and RF plumbing, all housed in a single cabinet of the type specified in paragraph 3.20.1. The receiver assembly shall perform and be designed in accordance with the requirements of subparagraphs hereunder and other applicable specification requirements. This unit shall be a stable, sensitive, wide-dynamic-range S-band receiver. It shall employ a TR device and a multisection input bandpass filter tunable over the range of 2.7 GHz to 2.9 GHz centered at the radar operating frequency. The receiver shall use a PIN-diode modulator operating as a Sensitivity versus Time Control unit (STC) ahead of the RF amplifier to provide controlled attenuation versus range. The receiver shall use a solid-state, low-noise mixer with input limiter protection against the transmitter pulse. The receiver shall provide a minimum of 20 dB of image rejection of frequencies generated in the mixer. The receive only Wx channel shall use the orthogonal output from the normal and passive horn when the ASR-9 is in CP. The orthogonal output from the normal and passive polarizers shall be gated by a RF switch before entering the single "S" band path through the rotary joint.

3.21.1 Inputs.- The inputs shall include but not be limited to the following:

(a) Channel A and Channel B COHO/STALO
(b) Channel A and Channel B Gated Low/High Beam Path
(c) Gated Orthogonal output from the antenna polarizers
(d) Channel A and Channel B triggers
(e) Two-level weather contour reports from the C&I processors

Switching shall be provided as required to insure active inputs to the WX channel are provided by the channel radiating out of the antenna. Switching shall be provided so that an LP signal is provided to the WX channel when the radar is in LP and the antenna orthogonal output is provided to the Weather Channel when the radar is in CP. The six-level weather processor shall have the following maintenance selectable feature for automatic selection of antenna polarization. When the number of weather cells with threshold crossings of level 2 and above exceeds 1% or less to 40% (selectable in increments of 1% or less) the antenna polarization shall automatically switch to CP. When the number of cells of level 2 and above drops below a lesser selectable value, the polarization shall automatically switch to LP.

3.21.1.1 Six-level Wx input during LP operation.- When the ASR-9 is operated in LP, the input to the 6 level WX channel shall be obtained from the A/D converters of the active target channel. The 6-level WX channel shall automatically adjust data to take into account the reduced sensitivity due to target channel STC, to the extent that this STC does not exceed the STC desired for a particular weather level.

3.21.2 Noise figure.- The noise figures shall be measured from a directional coupler on the antenna side of the receiver assembly to the output of the IF distribution amplifier. The overall noise figure relative to minimum theoretical noise shall be no greater than that specified over the frequency range of 2700 to 2900 MHz when measured with the transmitter off and the transmission line terminated into the dummy load. Theoretical noise is to be defined as the product of Boltzman's Constant, effective noise bandwidth in Hz and temperature in degrees Kelvin.

3.21.3 Transmit/Receive (T/R) devices.- T/R device shall be employed as necessary to protect the receiver and to insure that the receiver has recovered to within 3.0 dB of its normal sensitivity within 5 microseconds of the firing of the transmitter. The recovery time specified above shall be obtained with the receiver PIN modulator set for minimum attenuation and with the receiver connected to the orthogonal port on the polarizer. Insertion loss of the T/R device shall be compatible with the system noise figure of 4.5 dB or less. The T/R devices shall not require a "keep alive" voltage source, and shall provide full receiver protection.

3.21.4 Receiver input bandpass filter.- Two bandpass filters shall be incorporated ahead of the RF amplifier. The WX channel shall switch in the proper bandpass filter for the selected ASR-9 channel. The filter shall be tunable over the range of 2.7 to 2.9 GHz. Tuning shall be accomplished by means of accurately calibrated micrometer adjustments. Every bandpass filter shall be calibrated and the micrometer settings for the complete frequency range from 2.7 to 2.9 GHz shall be furnished in the form of a permanent graph that is attached to the equipment near the filter in a readily visible location. The micrometer shall be replaceable and the filter shall meet all the applicable specification requirements after one or more of the micrometers are replaced and the filter is recalibrated. The resetability of the filters shall be such that it shall be possible to repeatedly tune the filter to any operating frequency in the operating range by reference to the graph and have the operating frequency in the operating range by reference to the graph and have the operating frequency fall within ±1.0 MHz of the center of the passband of the filter. When the filter is tuned, the ripple insertion loss and bandwidth shall be in accordance with the requirements specified herein:

Attenuation	Bandwidth
3 dB	10 MHz minimum
20 dB	28 MHz maximum
40 dB	46 MHz maximum
60 dB	72 MHz maximum
Insertion loss	Compatible with System Noise Figure of 4.5 dB or less
Ripple in passband	0.15 dB maximum

The mechanical mounting of the filter in the system configuration shall be such that a new filter of thirty (30) inches in length (in line, input to output connection) could be inserted without change to any support brackets, mechanical access, or ease of removal.

3.21.5 Antenna beam selector.- When the ASR-9 is operating in CP, the beam selection shall be performed at the output of the orthogonal ports of the polarizers and shall preceed the STC circuitry. The WX beam switching circuitry shall be driven by the WX channel antenna pattern selection signals in the CP mode. The characteristics of the WX antenna pattern selection shall meet the requirements of paragraphs 3.11.5.2, 3.11.5.3, and 3.11.5.3.1. When the ASR-9 is operating in LP, the input to the WX channel shall be derived from the selected channel target receiver.

3.21.6 Sensitivity Time Control (STC).- The STC circuit, by control of the PIN device bias, shall provide time-varying gain characteristics. An STC "OFF" capability shall be provided at the local site for maintenance purposes. The STC function shall automatically be switched off when the antenna is operating in CP and collecting level 1 weather data. The STC characteristics shall be generated digitally. The digital STC generators and the D/A converters shall be located in either the WX receiver or processor cabinet provided performance characteristics are not affected by the location. The STC characteristics shall be generated by adjustable circuits with minimum range of adjustment as follows:

(a) The initial value of receiver attenuation shall be adjustable from the minimum insertion loss of the device to at least 60 dB.

(b) The attenuation shall decrease exponentially from 3/8 - 6 nmi at a rate which is adjustable from 0-12 dB/octave in increments of 1 dB per octave. Independent control of the slope shall be provided in 1 dB increments in 7 other range zones: 6-8, 8-12, 12-16, 16-24, 24-32, 32-48, 48-60 nmi.

(c) The attenuation shall not differ from the curve programmed above by more than 1.5 dB or five percent of this STC curve (whichever is greater) for any programmed attenuation up to 60 dB over the range of service conditions.

(d) The low beam STC attenuator shall have the capability of applying maximum attenuation from zero range to 1 nm prior the shortest range of which the low beam is selected and shall recover to the programmed STC attenuation within the specified STC accuracy by the time the low beam is switched on.

3.21.7 Receiver blanking.- Receiver suppression, in addition to the STC (paragraph 3.11.5.2.1) shall be provided to prevent evidence of the transmitter pulse in the output of the receiver. This feature shall not affect the receiver recovery time.

3.21.8 Receiver.- The ASR-9 shall include a WX receiver with the dynamic range and linearity necessary to drive the A/D converters to saturation without introducing harmonics or cross products deleterious to the WX channel performance. The receivers shall include the following functions:

(a) RF amplifier (paragraph 3.11.6.1)
(b) Signal Mixer (paragraph 3.11.6.2)
(c) IF Preamplifier (paragraph 3.11.6.3)
(d) IF Amplifier (paragraph 3.11.6.4)
(e) Phase detectors (paragraph 3.11.6.5)
(f) Video Amplifiers (paragraph 3.11.6.6)
(g) A/D converter (paragraph 3.11.6.7)
(h) I&Q accuracy (paragraph 3.11.6.9)

3.21.9.- Not used.

3.21.10.- Not used.

3.21.11.- Not used.

3.21.12.- Not used.

3.21.13 WX channel processor.- The separate weather channel processing shall be synchronous with the MTD and shall be similar to the two level weather processing with the following exceptions:

(a) Six weather levels generated by six weather thresholds corresponding to the standard NWS values shall be continuously processed. These values shall be +30 dBz, +41 dBz, +46 dBz, +50 dBz, and +57 dBz. (Level one is below 30 dBz and level six is greater than 57 dBz).

(b) Four different filters for each range cell shall be generated to separate weather returns from ground clutter. Three of these filters shall have notches of different widths centered at zero velocity and the fourth filter shall pass all velocities. These filters shall be selected by areas dependent upon the ground clutter in each area and the filter used shall be chosen independently for each threshold so that it is appropriate for the detection of each weather level as described below.

(c) Weather levels 2 through 6 shall be normalized using a combination of a front end STC attenuation independent of beam selection and a detection threshold dependent on both range (1/16 nmi) and beam. When the antenna is operating in CP, all weather data input shall be from the orthogonal ports of the antenna; when operating in LP, all weather data shall be from the target channel A/D. Level 1 weather shall employ the target channel STC in LP and no STC in CP. All levels of LP weather data shall be normalized to the extent that the desired weather STC for a particular weather level exceeds target channel STC.

Weather processing shall occur on every CPI and values shall be output at 1/2 nmi range increments with each determination using information from a 1 nmi range interval. The weather measurements for the two PRFs in the CPI pair shall be combined in such a way as to help eliminate range ambiguous weather echoes and the weather thresholds shall be chosen to compensate for any bias introduced in this operation.

The four Doppler filters used for rejection of ground clutter shall be programmable and the contractor shall provide an initial recommended set. The Doppler filtering hardware shall provide sufficient arithmetic precision such that at least 40 dB rejection of antenna modulated ground clutter is possible.

The first step in the generation of the 6 level weather product shall be the generation of the four clutter reduction filters for each CPI-range cell. Levels 2-6 shall be processed during the same scan and level 1 shall be processed during alternate scans due to it's different STC requirements.

The weather level detections shall be generated every 1/2 nmi interval and shall represent an estimate of the weather level for the 1 nmi range segment centered on that interval. The processing for the 1 nmi segment shall be accomplished using an "m of n" (m = 8, n = 16) detector for each weather level operating on threshold crossings calculated from filter output magnitudes for each range gate (1/16 nmi).

The inputs to the "m of n" detectors shall be selected from one of the four clutter reduction filter outputs using a site dependent map (range resolution 1 nmi, azimuth resolution 1 CPI pair) for each level. This map shall store the information required to select one of the four doppler filter outputs for each weather detection level and each spatial resolution cell. The detected weather level, for every CPI 1/2 nmi interval, shall be the highest level output from the "m of n" detectors. The output for the CPI pair shall be the lower of the two levels detected for the range interval (1/2 nmi). The map shall implement an ability to suppress (censor) the detection of weather below a specified level in each azimuth (CPI pair) cell with 1 nmi range resolution. The contractor shall provide the means to generate the site-dependent stored map in a time period not to exceed 8 hours.

3.21.13.1 Temporal smoothing.- This function shall develop a weather map with 1/2 nmi range granularity and 1.4 degrees azimuth granularity, approximating the median weather level detected during 3 pairs of scans (scans 1 and 2, 3 and 4, 5 and 6). Weather level for a scan pair shall be generated by replacing odd scan data (0, level 1, or censored) with any even scan data other than zero (levels 2-6 or censored). If the weather levels reported on the first two scan pairs match, this level shall be stored in this map. If they do not match, the level stored in this map shall be the smaller of the levels on the first two scan pairs unless the third scan pair reports a higher level, in which case, the level stored shall be one higher than the smaller level of the first two scan pairs. If one of the three input levels is censored, the smaller of the other two shall be stored. If more than one of the three input levels is censored, the map is censored.

3.21.13.2 Spatial smoothing.- This function shall develop a weather map with 1/2 nmi range granularity and 1.4 degrees azimuth granularity defining the level of weather equalled or exceeded in a programmable fraction of a 9 cell cluster (each cell and its 8 neighbors). Censored cells shall be ignored in both the numerator and denominator of the fraction, except that the output data shall be designated as censored when the denominator is too small to provide meaningful data.

3.21.13.3 Contouring.- This function shall develop and report a single weather map with 1/2 nmi range granularity and 1.4 degrees azimuth granularity defining the highest level of weather detected in 3.21.13.2 in each 9 cell cluster (each cell and its 8 neighbors). When possible, if all 9 cells are censored, the level output shall be the level contoured at an adjacent range or azimuth where this condition does not exist. Collection of all weather data shall be completed every six scans or less at the radar site and completely processed and transferred (all 30,720 cells) into the SCIP within three scans or less of completion of collection of weather data. When the SCIP parameters are chosen to minimize delay in the SCIP, the weather data of each range/azimuth cell shall be displayed no more than nine scans after the collection of the first sample of data in that cell and all surrounding cells used in the smoothing and contouring processes. When operating in the sector mode after the system has been running, the display of weather data at each range/azimuth cell shall be updated every seven scans or less. The contractor shall provide a maintenance selectable parameter in the SCIP to allow the updating of the weather data being provided to the displays as weather data is received from the local site (in sectors) or to hold the updating of weather data until all weather data has been received (360 degrees x 60 nmi). In addition, in the event of parity error in a 1.4 degrees weather data sector, the weather being provided to the displays in this sector shall be from the last weather updating period.

3.21.14 WX channel output.- The output of the WX processor shall be six calibrated weather reflectivity (dBz) levels as defined by the National/Weather Service as follows:

0-30 dBz	Level 1
30-41 dBz	Level 2
41-46 dBz	Level 3
46-50 dBz	Level 4
50-57 dBz	Level 5
57 dBz and above	Level 6

Level 1 weather data shall not be range normalized. Level 1 weather data shall be compared to two thresholds. The first threshold shall be located at 30 dBz and shall be range normalized. The second threshold level shall be a site selectable parameter between 0 dB and 10 dB (signal pulse to noise in .5 dB steps) above RMS noise level and shall not be range normalized.

3.21.15 Weather data mode select unit.- The contractor shall provide two weather data mode select units, each with dual isolated outputs. As part of the receive only WX channel, the capability shall be provided to accept the two-level weather contour point reports from the active channel C&I processor as well as the six-level reports generated within the receive only WX channel. On control signal command from the remote or local site control panels, the mode select switch shall transfer either the two-level reports or the six-level reports to the remote site, as appropriate. All weather data shall be transferred to the remote site in contractor selected format. All weather data (approximately 30,720 resolution cells) from 2 level or 6 level weather processor shall be transferred to the SCIP's in three scans or less over one 9600 bits per second modem. The contractor shall provide the capability to reformat the weather data into any message length, word length, or bit assignment. This shall be accomplished by changing firmware at a central repair facility (paragraph 3.4.4.1). In the event the weather format is changed, the contractor shall provide the capability to drive at least two additional 9600 bits per second modems.

4. QUALITY ASSURANCE PROVISIONS.- This section establishes the requirements and criteria for verification of ASR system performance and design characteristics. The scope of these requirements includes the system itself, all functional areas within the system, and all internal and external interfaces. Verification is accomplished in phases throughout system acquisition. All verifications shall be accomplished to the satisfaction of the Government unless signed waivers are obtained from the Procuring Contracting Officer.

4.1 General quality assurance requirements.- The basic objectives of the quality assurance requirements are to provide early visibility of and confidence in ASR system characteristics and performance parameters and to assist in the verification of section 3 requirements as early as possible. The final results of the quality assurance program will be a high degree of confidence that the implemented ASR system meets all the requirements of section 3 in its intended operational environment. Quality assurance shall be obtained by verification conducted in phases; each phase designed to provide increased assurance that required system program objectives will be met. Verification shall commence with Development Test and Evaluation (DT&E), and shall be considered complete upon satisfactory verification of required system performance during in-plant Acceptance Test and on-site Field Test and Evaluation. Objectives of an earlier verification phase must be satisfied and deficiencies must be resolved before a later verification phase is initiated. The results of each verification phase shall determine the advisability of proceeding to the next phase. The quality assurance phases shall be as follows:

(a) Phase IA, Development Test and Evaluation, in-plant.

(b) Phase IB, Field Test and Evaluation, at a field site selected by the Government, for the first system.

(c) Phase II, in-plant test quality assurance for production of ASR systems and quality assurance requirements for delivery, installation, and on-site test of ASR production systems.

4.1.1 Phase IA Development Test and Evaluation (DT&E).- Phase IA DT&E shall provide answers, as early in the program as feasible, to the majority of the critical questions and areas of risk associated with development of the ASR. This verification activity also demonstrates that engineering design and development are complete, that design risks have been minimized, and that the system can be expected to meet engineering and operational specifications. It shall identify the degree to which the contract specifications have been met, insure system compatibility, provide estimates of system reliability/maintainability/availability performance. Verification proceeds from the component level, through integrated verification of functional areas and interfaces within the complete system, and to the complete system, in as near an operational configuration and environment as practical. DT&E shall be conducted on components, subsystems and the entire system during development, and in general, prior to field operational testing. DT&E shall be conducted in two phases -- Phase IA and Phase IB. The purpose of Phase IA DT&E is to emphasize normal quality control of design, development and/or construction and to verify compliance of the ASR with as many of the requirements of section 3 as are practical. Phase IA DT&E shall include component verification of hardware integration verification and system verification. The results of Phase IA DT&E shall be used to determine the advisability of proceeding to Phase IB FT&E.

4.1.2 Phase IB Field Test and Evaluation (FT&E).- The purpose of Phase IB FT&E is to emphasize quality and visibility of the design when it is subjected to the test site and live air traffic control environment. Phase IB FT&E shall be conducted "outside" at the designated Government test facility. The test facility shall consist of that civil airport environment and interfaces, readily available to the contractor. External operational system interfaces shall be with GFE ARTS IIIA and ARTS II systems. Verification shall emphasize operational parameters not feasible to test or evaluate in the "in-plant" environment. Verification shall include installation and system checkout verification, verification of the integrated functional areas within the complete system, and verification of the complete system in the test site environment. Draft procedures for site installation and check out as well as integration verification procedures shall be developed and used to the maximum extent feasible. Testing shall be conducted using live inputs and recorded or simulated inputs as necessary for verification of specified ASR performance parameters in an operational environment. Results of this on-site test is expected to complete development verification of the ASR System and provide a base for determining specification compliance.

4.1.3 Phase II Production Acceptance Test and Evaluation (PAT&E).- This series of verification tests provides confidence that the production components, equipment, and systems meet the contracted specifications.

4.1.4 Quality control system.- The contractor shall establish and maintain a quality control system in accordance with FAA-STD-016. The submission and approval of test procedures shall be as specified in FAA-STD-016. The contractor shall furnish a test plan which identifies all in-process and acceptance tests to be performed on units, subsystems, and systems to demonstrate compliance with all specification and contract requirements.

4.1.5 Software.- The contractor shall establish and maintain a software quality assurance program in accordance with FAA-STD-018. Tests shall provide confidence that the software design and performance satisfies the system requirements of section 3. Tests shall exercise all algorithms in their final form, and shall include throughput type tests under low to high processing load conditions.

4.2 Phase IA Development Test and Evaluation (DT&E) requirements.- Phase IA DT&E shall consist of the inspections, analysis, demonstrations, and tests performed on a system, major subsystem, and major unit (e.g., STALO, COHO, weather processor, etc.). As a minimum the following tests:

(a) Phase IA Type Test, paragraph 4.2.1.

(b) Design Qualification Tests, paragraph 4.2.2, and FAA-G-2100/1.

(c) Preliminary tests as required by FAA-G-2100, paragraph 1-4.3.1.

(d) Production acceptance tests, reference paragraph 4.4.2.

4.2.1 Phase IA type test.- The Phase IA, type test performed under the service conditions (paragraph 3.3.2) shall be performed in accordance with 1-4.3.3 and subparagraphs and 1-4.12 and 1-4.12.1 of FAA-G-2100/1. One complete channel and the common equipment of each type test system are required to be tested under service conditions. The second channel shall be connected to the first channel and operated under normal test conditions, or alternatively, signals and other inputs from the second channel may be simulated. Antenna type testing may be performed separately; however, the type test system shall be connected to an installed operating antenna so as to provide a true operating environment. The channel being tested under service conditions shall be selected as the master channel.

4.2.1.1 Phase IA type test requirements.- The contractor shall submit type test procedures and test data sheets for approval by the Government. As appropriate, system performance tests shall be made in all modes of operation; i.e., single channel/in phase/quadrature MTD. All the following paragraph references hereunder shall include subparagraphs théreto. As a minimum, Phase IA type test shall consist of the following:

	Test	Reference Paragraph
S,	WX Channel	3.21
S, V	Transmitter peak power	3.4.3
S, V	Pulse width	3.4.3
S	Noise figure	3.4.3
S	MTD receiver sensitivity	3.4.3
S, V	Data delays	3.4.3.6
S, V	RMS	3.13
S	Factory run-in test	3.8.4.6
V	Factory run-in test	3.8.4.6
S	Operating characteristics (Rotary joint)	3.8.6
S, V	Azimuth pulse generator	3.8.8.3
	Antenna (electrical) pattern tests	3.9
S	RF pulse spectrum	3.7.8
S, V	Transmitter output tube	3.10.3
S	Frequency tolerance	3.10.2
S	STC/Antenna beam selector	3.11.5.2
S	Antenna pattern selection	3.11.5.3
S	C&I processor performance	3.12.4
S	SP performance	3.12.5
S	STALO performance	3.11.1.3
S	COHO performance	3.11.1.4
S	MTD system performance	3.12
S	RFG performance	3.11.1
S	Maintenance display performance	3.18.11
S	Surveillance and communications interface processor performance	3.12.7
S, V	Power supply performance	3.19

S	Control System	3.16
S	Digital Recorder Output	3.18.10
S	ASR-9/Mode S interface	3.12.5

All of the above tests shall be performed as type tests; those marked 'S' shall be performed over the service ambient conditions, those marked 'S, V' shall be performed over the range of service ambient conditions and simultaneous variation of service line voltage; those marked 'V' shall be performed over the variation of service line voltage.

4.2.2 Design qualification tests.- Design qualification tests specified in subparagraphs hereunder are, in addition to those required by 1-4.3.2 and subparagraphs in FAA-G-2100/1. These tests shall be performed on the first system to be delivered under the contract.

4.2.2.1 Antenna assembly and alignment.- The antenna shall be assembled and aligned in accordance with procedures contained in the instruction manual (paragraph 3.18.1) and utilizing only those alignment fixtures and tools provided or normally available for field installation. Sufficient antenna testing (paragraph 3.9.11 and subparagraphs) shall then be performed to demonstrate that the antenna can be field installed with resultant performance in accordance with specified requirements.

4.2.2.2 Antenna manufacturing contour tolerance test.- The design qualification tests for the antenna, static load, shall be accomplished with one antenna under static load to determine compliance with requirements for maximum wind velocities and ice conditions in accordance with the requirements of paragraph 3.8.7.1. The contractor shall submit a detailed description of the proposed static load test for Government approval.

4.2.2.3 System alignment.- The system shall be completely aligned utilizing only the procedures contained in the instruction manual (paragraph 3.18.1) and the standard test equipment. Sufficient testing shall then be performed to fully determine the adequacy of the manual and the standard test equipment for optimizing system performance.

4.2.2.4 System and unit coverage verification.- Unit and system performance characteristics shall be measured as necessary to verify the specified system coverage (paragraph 3.4.2). Utilizing the actual measured values, range calculations shall be performed, with the results verifying the requirements of paragraph 3.4.2.

4.3 Phase IB Field Test and Evaluation (FT&E) requirements system.- The field test and evaluation requirements for the first article ASR-9 System shall be performed by the contractor as required at a site to be identified in the contract. For this test, the Government will designate a selected site/airport and furnish a standard ASR building and standard radar tower (height to be provided at a later time). All test equipment to demonstrate ASR-9 performance, remote performance monitoring and all other maintenance tasks, shall be provided by the contractor. Upon completion of the field operational demonstration and Government acceptance of the first system, the standard test equipment shall be removed and returned to the contractor. These Phase IB FT&E tests, as a minimum, shall include the following:

(a) Reliability demonstration (paragraph 4.3.1)

(b) Maintainability demonstration (paragraph 4.3.2)

(c) Peak of beam system coverage (paragraph 4.3.3).

(d) System coverage (paragraph 4.3.4)

(e) Operational subclutter visibility (paragraph 4.3.5)

(f) Radar accuracy and resolution (paragraphs 4.3.6, 4.3.7, and 4.3.8) (Range, Azimuth, and dissimilar size targets)

(g) Tangential target detection (paragraph 4.3.9) (Target in the clear and target over clutter) (Cancellation of fixed 2nd time around targets/clutter)

(h) Interfaces test (paragraph 4.3.10) (Display automation interfaces)

(i) Remote monitoring subsystem (paragraph 4.3.11) (Test equipment requirements, system measurement characteristics, Off-line diagnostics, reference paragraph 3.13.2)

(j) Weather channel (paragraph 4.3.12) (Weather detection sensitivity and calibrated levels)

(k) Electrical power (paragraph 4.3.13) (Energy efficiency, Power interrupt/data loss and compatibility with existing E/G and A/C)

(l) Environmental characteristics (paragraph 4.3.14) (Cooling - ventilation scheme, compatibility with existing ASR tower)

4.3.1 Reliability demonstration.- The contractor shall perform a reliability demonstration test on an ASR-9 single channel. The test shall be performed with a complete system configuration except for the antenna subsystem. The single channel equipment shall be connected to dummy loads, delay lines, etc. The reliability demonstration shall be performed in accordance with Test Plan III, test level A-1 of MIL-STD-781B. Preventive maintenance tasks, where required to be accomplished during the reliability demonstration, shall meet the requirements of paragraph 3.6. Testing shall be performed at an ambient temperature of 25 degrees C $\pm$ 5 degrees C (input air) with voltages and frequency within the range specified under the required service line conditions of FAA-G-2100.

4.3.1.1 Reliability demonstration test log.- A chronological test log shall be maintained throughout the reliability demonstration test. This log shall provide the dates and times of all significant events. A list of events which must be recorded is:

(a) Power on and off times of each equipment or equipment group.

(b) Start and stop times of demonstration testing.

(c) Functions, modes and phases of test, including random tests.

(d) All interruptions of tests, including all failures.

(e) Failure report numbers (logged at time of failure).

(f) Time to restore each failure, including specifically: diagnosis time, repair-replace time, and checkout time (including recalibration, reprogramming, etc.).

(g) Temperature at 4-hour intervals.

(h) Any unusual conditions in equipment under test, auxiliary equipment, source power, or environment.

4.3.1.2 Reliability demonstration test report.- A reliability demonstration report shall be submitted in accordance with the contract schedule. This report shall summarize all test results obtained during the tests, and shall provide in detail the rationale and calculations of demonstrated reliability of each subsystem. The report shall also include the cumulative failure summary report and a copy of the reliability demonstration test log.

4.3.2 Maintainability demonstration tests.-

4.3.2.1 Corrective maintenance test.- The contractor shall conduct a corrective maintenance demonstration test in accordance with Method 9 (Consumer's risk = 10 percent) MIL-STD-471A. The demonstration test shall be based on failure modes statistically chosen. These choices shall be based on information resulting from the failure mode effects and criticality analyses (paragraph 3.6.1.3.4) and RADC-TR-64-377, "Study of Part Failure Modes."

4.3.2.2 Preventive maintenance test.- The contractor shall perform the preventive maintenance demonstration in accordance with Government approved plans and procedures. The Government will select any number of preventive maintenance tasks which are contained in the approved procedures which shall be performed during the preventive maintenance demonstration test. The total number of tasks shall be the same as those contained in the instruction manuals. The procedures shall also list the recommended frequency at which the tasks are performed, and the time required to perform these tasks. Equipment required for on-line use shall not be preempted for preventive maintenance, nor shall preventive maintenance be performed on equipment which is in use in the on-line system. The ability to perform preventive maintenance without degrading system performance shall be demonstrated.

4.3.2.3 Maintainability demonstration test log.- A chronological test log shall be maintained throughout the maintainability demonstration tests. This log shall provide the dates and times of all significant events. A list of events which must be recorded is:

(a) Power on and off times of each equipment or equipment group.

(b) Start and stop times of demonstration testing.

(c) Functions, modes, and phases of task, including random tasks.

(d) All interruptions of task, including all failure details.

(e) Any unusual conditions in equipment under test, auxiliary equipment, source power, or environment.

4.3.2.4 Maintainability demonstration test report.- A maintainability demonstration test report shall be submitted in accordance with the contract schedule. This report shall document the results of all tests. It shall provide the detailed calculations of the maintainability demonstration of each subsystem. The report shall also include a copy of the maintainability demonstration test log.

4.3.2.5 Module Maintenance Demonstration Test (MTTR).- The contractor shall develop corrective maintenance demonstration plans in accordance with MIL-STD-471A and shall conduct demonstration tests in accordance with test Method 10 thereof. Fault simulation shall be satisfied in accordance with appendix A of MIL-STD-471A. All modules shall be allocated at least one maintenance task with a minimum of 50 maintenance tasks total (paragraph 3.6.2.3.1).

4.3.3 Peak of beam system coverage.- The contractor shall demonstrate that the system coverage requirements as outlined in paragraph 3.4.2 are met or exceeded. Tests shall include at least ten scheduled radial flight tests (five inbound, five outbound) extending between 30 nm and 60 nm in range from each test site. For this test the antenna shall be set to have the nose of the beam at + 4 degrees above the horizontal to reduce effects of clutter return and multipath propagation. Blip/scan data and range data shall be recorded for each scan during all flights. Detection performance shall be related to test results using radar cross-section data approved by the Government for the flight check aircraft. Detection performance referred to the standard one square meter ($1m^2$) target shall equal or exceed the requirements of paragraph 3.4.2. The Government shall select the altitude at which the flight check shall be flown for this portion. Once the peak of beam is determined for a $1m^2$ target, the contractor shall develop a Radar Cross Section (RCS) detection capability for the entire lobe for a $1m^2$ target. This shall cover - .5 degrees to + 60 degrees.

4.3.4 System coverage.- The contractor shall demonstrate the range capability of the ASR for a $1m^2$ target, Pd .8, LP, and 10^{-6} false alarm probability in the clear. Tests shall be conducted in increments of 1,000 feet up to 10,000 above site elevation, and at 15K and 20K above site elevation. The antenna shall be aligned to set the nose of the beam at + 2 degrees. Tests at 1,000 feet and 10K above the site shall include at least ten scheduled radial flight tests (five inbound, five outbound) extending from the antenna to the outer fringe of the coverage. Tests at the remaining altitudes shall include at least six scheduled radial flight tests (three inbound, three outbound) to cover the inner fringe coverage and the outer fringe coverage. Blip/scan data and range data shall be recorded for each scan during all flights. Detection performance shall be related to test results using radar cross-section data approved by the Government for the flight check aircraft. These results shall be converted to indicate the expected coverage for a $1m^2$ target.

4.3.5 Operational Subclutter Visibility (SCV).- The contractor shall demonstrate that the operational SCV of his system is 42 db or better using live clutter and the antenna rotating. The procedure to be used shall be in accordance with FAA report RD-76-190 dated 8 March 1977, section V, paragraph F. Blip/scan data shall be collected over ten scan intervals and recorded. This test shall be repeated ten times for each channel on seven consecutive days and then averaged to determine the operational SCV. The blip/scan data shall be recorded at the output of the SP.

4.3.6 Azimuth resolution.- The ASR contractor shall demonstrate radar azimuth resolution as follows using targets of opportunity.

(a) As a minimum, targets with a lateral separation of 1.5 nm and at radar ranges out to a maximum of 25 nm shall be detected and reported as individual targets.

(b) As a minimum, targets with a lateral separation of 2 nm and at radar ranges of 25 nm out to 40 nm shall be detected and reported as individual targets.

Recordings shall be made of digital target report output data to demonstrate the preceding azimuth resolutions performance requirements that results from various targets of opportunity that are observed to have parallel or crossing tracks. Azimuth resolution shall be determined from a series of such recorded runs wherein each run contains dual target reports of target positions before, during, and after the nearest approach of the target tracks. Such recordings shall be made for a minimum of 25 runs at each of the following radar ranges; 0 to 10 nm, 10 to 20 nm, 30 to 40 nm, 40 to 50 nm, and 50 to 60 nm.

4.3.7 Range resolution.- The contractor shall demonstrate range resolution of 1/8 nm or better between two aircraft. The two aircraft will be flown at the same azimuthal bearing at a minimum altitude separation. Recording shall be made of digital target report output data to demonstrate the ability of the radar to resolve two aircraft as separate and distinct targets when separated by 1/8 nm or more. Numerous runs shall be made at various ranges up to 60 nm from the antenna.

4.3.8 Two target resolution.- The ASR contractor shall demonstrate ASR System performance and ability to detect and track two or more aircraft which are in close temporal and spatial proximity of each another. This characteristic shall be demonstrated for similar size targets and also for two dissimilar size targets (e.g., T-33 with a radar cross-section of 2.2 square meters versus a 707 with a rated radar cross-section of 13.8 square meters). Recordings shall be made of digital target report output data of similar size targets of opportunity or crossing tracks. Such individual aircraft tracks shall not be lost or unresolved for more than two scans. Such recordings shall be made for a minimum of 25 runs. Recordings shall be made of digital target report output data of two dissimilar size flight check aircraft. One aircraft to be flown straight and level with the second, at another flight level, weaving across the same flight direction. Except for the condition wherein both target reports fall into the same track, or are separated by distances that fall within the azimuthal or range resolution, these two aircraft tracks shall not be lost or unresolved for more than two scans. Such recordings shall be made for a minimum of 5 runs.

4.3.9 Detection of tangential targets.- The contractor shall demonstrate the ASR capability to detect targets flying tangentially in the clear, over clutter, and in weather over the coverage area up to 60 nm from the antenna site at various altitudes. Range, altitude and blip/scan data shall be taken on various targets of opportunity to determine the performance of the system. For this test the antenna shall be set to have the nose of the beam at + 2 degrees. The contractor shall demonstrate that there is no evidence of fixed 2nd time around targets/clutter at the output of C&I.

4.3.10 Interface test.- The contract shall demonstrate that the ASR-9 System can interface and operate compatible with the following remote site equipment:

(a) ARTS IIIA
(b) ARTS II
(c) Not used
(d) ATCBI-4/5
(e) Video mapper
(f) BRITE

4.3.11 Remote monitoring subsystem.- The contractor shall demonstrate the operation, ease of calibration and stability of the RMS. This will include, but not be limited to, remote monitoring of the dual ASR channel performance, off-line diagnostics of the ASR, beacon performance and the compatibility of RMS test equipment for use during corrective maintenance.

4.3.12 Weather channel.- The contractor shall demonstrate the operation and stability of the receive only weather channel, reference paragraph 3.21. This will include, but is not limited to; a) a demonstration of the stability of the six weather thresholds corresponding to the standard NWS values, b) a demonstration of readily interpreted weather contours with the least amount of ambiguity between contour levels or boundaries to demonstrate smoothing from scan-to-scan, and c) a demonstration of operator controls and indicators to flag availability of weather data and provide for operator selection of at least two weather contour levels.

4.3.13 Electrical power.- Total consumption shall be measured at the service entrance for the complete ASR facility during the evaluation period to determine the energy efficiency and compatibility with existing E/G and environmental subsystem. Power interrupt/switching between commercial and E/G sources shall be evaluated to insure minimum disruption to the system in an operating environment.

4.3.14 Environmental characteristics.- The contractor shall demonstrate the environmental characteristics that the ASR Systems creates at the radar site. This will include, but is not limited to, the following:

(a) Interior temperature control as affected by transmitter heat transfer and ventilation shall be demonstrated;

(b) General characteristics of heat transfer from electronic equipment cabinets shall be demonstrated;

(c) Interior and exterior noise levels shall be measured for comparative purposes and to insure that noise level produced during normal system operation does not exceed limits specified in FAA-G-2100.

4.4 Phase II Production Acceptance Test and Evaluation (PAT&E) requirements.- Phase II is the test quality assurance for production of ASR Systems. These tests will include the following:

(1) Production acceptance tests in accordance with paragraph 4.4.2.

(2) Type tests as specified in paragraph 4.2.1.1, and in accordance with requirements for Type Test Equipment Selection as specified in paragraph 1-4.3.3.1 of FAA-G-2100.

(3) Delivery, installation, and on-site tests as specified in section 5.

4.4.1 System and subsystem/unit production test.- Each radar channel definition delivered under the contract shall be completely wired and assembled in its final installed configuration for the system production tests at the contractors manufacturing location. System production testing shall be performed with the equipment fully assembled and operable as a complete dual channel system. Antenna testing may be performed separately; however, an installed antenna complying with all performance requirements specified herein shall be available for system testing unless the Government specifically agrees that testing on a dummy load is permissible. Tests shall be performed on each of the dual channels. All spares shall be tested in accordance with the provisions of the contract. After completion of all regular production tests, each radar channel shall be aligned to produce optimum performance and allowed to operate for a period of 24 hours without readjustment. At the end of this period the equipment shall meet all applicable specification requirements.

4.4.2 Production tests.- The following listed tests shall be performed on each ASR System to be delivered to the Government in order to demonstrate compliance with specified requirements. All the following paragraph references hereunder shall include subparagraphs thereto. Testing shall also include 6 level WX and RMS.

Tests	Paragraph Reference
System Production Tests	
Transmitter peak power	3.4.3
Pulse width	3.4.3
Average PRF	3.4.3
Noise figure	3.4.3
Receiver sensitivities	3.4.3
System stability	3.4.3.1
Capacity	3.4.3.2
RF pulse radiated spectrum	3.7.8
TR device, recovery time	3.11.5
STC	3.11.5.2.1
Antenna pattern selector	3.11.5.3
RF plumbing, pressurization integrity	3.14
Trigger requirements	3.12.2
DSP system performance	3.12.3.3
Test target generator	3.13.3
RFG performance	3.11.1
Point of control	3.16.1
Alarm controls	3.16.9
C&I output signals	3.12.4.1
SP output signals	3.12.5.2
SCIP output signals	3.12.7.2
Maintenance display performance	3.18.11
Power supply metering	3.19.1.10
Digital recorder output	3.18.10
SP performance	3.12.5

Tests	Paragraph Reference
Subsystem/Unit Production Tests	
Radiated frequency	3.4.3
RF drive	3.10.9
RF amplifier	3.11.6.1
Antenna	3.4.3
Factory run-in test (antenna)	3.8.4.6

Contour deflection	3.8.7.1
Operating characteristics (Rotary joints)	3.8.6.1
Isolation (Rotary joints)	3.8.6.2
Azimuth pulse generators	3.8.8
VSWR (antenna)	3.9.2
Antenna pattern (electrical) tests	3.9
X-radiation shielding	3.10.6

5. ON-SITE INSTALLATION, TESTING, AND ACCEPTANCE.- This specification contains requirements for the on-site installation, alignment, test, and acceptance of the ASR-9 integrated electronic system package in Government owned ASR buildings at designated locations. Requirements are specified herein for ASR-9 installation at a newly established ASR site within an essentially vacant ASR building and requirements are also specified for onsite test and acceptance with no interference to the operations of the ASR-4, 5, or 6 or beacon equipment being replaced.

5.1 Equipment and services to be furnished by the contractor.- The contractor shall furnish all materials and services necessary to install, align, and test the ASR electronic equipment package and specified contract schedule equipment at locations specified by the Government. At those ASR sites wherein the older model ASR/ATCBI equipment to be replaced remains in operation, within the same ASR building, the contractor shall install and test the ASR-9 without interference with on-going operations. A general installation plan shall be furnished that outlines the onsite installation, testing, and acceptance procedures that are applicable to a new ASR site and also to that of an operational site to replace older model ASR equipment with minimal interruption of radar service. This shall assume that any work requiring shut-down of the operating system shall be accomplished during the hours of 10:00 p.m. until 6:00 a.m. based on Government approval.

5.1.1 General.- The ASR System complex shall be completely operational and ready for FAA flight testing upon completion of the tasks specified herein. Any equipment, item, part, or service, not specifically designated in the contract as Government furnished, necessary for the proper operation of the system in accordance with this specification shall be furnished by the contractor even though that equipment, item, part, or service may not be specifically provided for or described herein.

5.1.2 Documentation to be furnished.-

(a) Standard system configuration installation drawings in accordance with paragraph 5.6.

(b) General installation plan in accordance with paragraph 5.4 for installing the ASR-9 in a Government ASR building including:

(1) Heating and cooling load and ventilation design calculations;

(2) Electrical load calculations; and

(3) Lightning storm protection requirements.

(c) Acceptance data package in accordance with paragraph 5.12:

(1) Acceptance record;

(2) Site predelivery preparation;

(3) Mechanical and electrical installation procedures;

(4) Operational performance; and

(5) Equipment inventory.

5.2.- Not used.

5.3 Air traffic control operating constraints.- When the construction, installation, and testing of equipment is performed in an operating environment, air traffic control activities and services shall have a priority over all contractor activities. There shall be no compromise in the safe and timely control of aircraft during these phases. The design of installation and testing procedures shall be based on continued use of existing ASR System. Installation services shall be performed in such a manner that disruptions to operating air traffic control facilities shall be minimized. Contractor actions that will interfere with or in any way have an impact on air traffic control activities and services shall be coordinated with and approved by the Contracting Officer or his designated representative in advance.

5.4 General installation plan requirements.- An ASR-9 installation plan shall be furnished by the contractor, for Government approval, that details the following actions:

(a) The contractor shall submit a site preparation report for each site scheduled to receive ASR equipment. The site preparation report will be used by the Government to prepare the site for installation of the contractor's equipment and to perform necessary services not required of the contractor. Therefore, all requirements to prepare the site for installation of the equipment shall be included. The report shall include, but not be limited to, the following:

(1) Typical floor plan layouts of ASR operational and maintenance equipment and spares.

(2) List of the ASR equipment and tools to be delivered to site by the contractor.

(3) Tabulation of the mechanical and electrical characteristics of each piece of equipment. Included shall be the definition of power requirements, circuit breaker panels, heat load in BTU per hour, starting surge current data, circuit breaker requirements, and power factors. The overall dimensions and weights (crated and uncrated) and any other information needed for the Government to prepare for the equipment installation shall be provided.

(4) Definition of cable and connector requirements for the complete installation, including typical cable access points and routing.

(5) Identification of requirements for Government and other contractor's services and test equipment, if any.

(6) List of test equipment, if any, which will be supplied by the contractor.

(7) A tabulation of typical or estimated work schedules, requirements and plans.

(8) Remote site requirements, including such items as site location criteria, site equipment, layouts, services required, and installation requirements.

(b) The plan shall furnish details of building refurbishment (plant and facilities) required prior to ASR-9 arrival; e.g., air conditioner/ ventilation, electrical service entrance, facility grounding counterpoise. The plan shall additionally, as a minimum, include a step-by-step procedure for installation of (1) electrical power distribution (excluding lighting, air conditioner/building ventilation system), (2) electrical wireway ducts and conduit; (3) waveguide; (4) electronic cabinet interconnecting cable; and, (5) electrical/electronic grounding systems. All such duct, conduit, cable waveguide, all power distribution systems and all support hardware shall be new material both in the building interior and that attached to the ASR tower. The following subparagraphs are not mandatory requirements for this specification but are provided as an example by the Government to illustrate a practical way to solve the preceding requirement for noninterference with operational radar service. The contractor's installation plan could recommend the following:

(1) Temporary ATCBI-5 installation/relocation by the Government within the building. This would permit Government removal of the old model ATCBI and clean-out unused conduits and ducts in that area.

(2) Installation of ASR-9 antenna and associated beacon antenna for initial operation with the ASR-4, 5, or 6 and ATCBI. Prior to any equipment modification not affecting the antenna.

(3) Time shared operation of the existing ASR-4, 5, or 6 and the ASR-9 through the use of waveguide switches.

(4) After successful acceptance tests of the ASR-9, removal by the Government of remainder of old model ASR equipment.

(c) Electrical power distribution.- The information plan shall describe all required electrical power panels, conduits and ducts required.

(d) Heating, cooling, and ventilation.- The contractor's proposed installation plan shall include heat, cooling, and ventilation calculations for the ASR building. The calculations shall be in accordance with FAA-C-2256a and FAA-Order-6970.1B, and shall take into account the heat load from the following:

	QTY	POWER (WATTS)	SUB TOTAL
ATCBI-5 Interrogator & Defruiter (FAA-E-2319b)	2	850	1,700
Beacon Performance Monitor (FAA-E-2502)	1	700	700
Interior Lighting			1,000

The Government will furnish the building heating, cooling, and ventilation equipment required by the approved plan and will provide the building entrance and exit ports for the contractor installed cooling/exhaust system described in paragraph 3.10.3.2 of FAA-E-2704.

(e) Lightning Protection.- The contractor's proposed installation plan shall detail the lightning protection requirements for the ASR tower and building for compliance with National Fire Protection Association, Lightning Protection Code, NFPA No. 78, and FAA-Order-6950.19. The lightning protection design shall be submitted for Government approval.

5.4.1.- Not used.

5.4.2.- Not used.

5.4.3.- Not used.

5.4.4.- Not used.

5.5 Conduct of installation.- The contractor shall schedule, coordinate, and staff his efforts for expeditious accomplishment with an absolute minimum of disruption to on-going Government operations. Once off-loading of antennas and equipment has started, installation work shall proceed on a regularly scheduled basis.

5.5.1 Grounding system.- Grounding shall be installed and connected in accordance with FAA-STD-019 and FAA-STD-020. The contractor shall provide grounding requirements to the Government.

5.5.2 Power distribution loading.- The contractor shall connect all electrical loads to the site power distribution systems in accordance with the following phase balancing requirement. The power distribution shall provide for balance loading of phases (within 10 percent) where three phase service is employed with all equipment in normal operation. The contractor shall provide the power and breaker requirements to the Government.

5.6 Standard system configuration.-

5.6.1 Transmitter site, Airport Surveillance Radar (ASR) building standard drawings- The Government owned ASR buildings and associated antenna support tower are as described in the FAA standard drawings:

D-5419-1 through 8, and 14, Airport Surveillance Radar, ASR-4 through ASR-8 Tower, Design and Installation Details

D-5417-1 through 9, ASR-4 Building

D-5648-1 through 10, ASR-5 Building

D-6048-1 through 10, ASR-4, 5, 6, Prefabricated Building

D-6075-153, Lightning Protection for ASR Towers

D-5454-1 through 18, Airport Surveillance Radar, ASR-4 through ASR-7 Tower Fabrication

D-5453-E1 through E16, Airport Surveillance Radar, ASR-4 through ASR-7 Tower Erection

Any changes required by the contractor to these FAA drawings in order to accommodate the standard ASR-9 local (radar) site equipment configuration shall be submitted for approval to the contracting officer.

The above listed FAA drawings shall be revised as necessary by the contractor to show the standard radar system configuration as specified in paragraph 3.5.1. The contractor shall furnish three copies of the drawings for review by the contracting officer. Approval or required changes for the initial submission will be transmitted to the contractor by the contracting officer within forty-five (45) days after receipt by the Government. Subsequent resubmissions will be returned within twenty-one (21) days.

The original copy of the drawings and reproducible copy shall be delivered to the contracting officer within fourteen (14) days after approval of each item (drawing).

All drawings shall be made on clear-print paper No. 1,000 H or equal with the FAA title block in the lower right hand corner. Provide 1/2 inch border lines on the top, bottom, and right hand side. Provide a 1-1/2 inch border on the left side. The drawings shall be made on "D" size sheets (22 inch x 34 inch). Sample title and index sheets will be furnished. Drawings will be prepared in accordance with FAA Standard, FAA-STD-002. These drawings will be reduced to 1/2 size by the FAA in the future. For this reason, the contractor shall take effort to assure that all drawings are clear and legible. The details and printing shall be of the size required for microfilming on 35mm film. The minimum letter height for 22 inch x 34 inch sheet will be 5/32 inch and .05 inch spacing between letters. All letters shall be vertical capital letters.

5.6.1.1 Airport Surveillance Radar (ASR-9) equipment installation.- The contractor shall transport, set in place, and secure the ASR-9 equipment provided by this specification. Installation shall include alignment, leveling, attachment of conduit, duct, waveguide, cable, and wires necessary for equipment operation.

5.6.1.2 Installation and checkout tasks.- The following tasks shall be performed by the contractor:

(a) Off-loading and positioning of all equipment in the locations designated in the appropriate site installation document.

(b) Interconnecting all ASR radar equipment cabinets.

(c) Install the ASR junction box at both the radar site and at the indicator site and relocate the existing ATCBI landline data circuit: 24 terminals and 2 coaxial cables.

(d) Installing the cabling from the ASR radar to the junction box.

(e) Installing the power wiring on the ASR radar power panel (FAA personnel will make the actual connection to the power source).

(f) Initial power application and equipment debugging.

(g) Adaptation to site parameters.

(h) Operational demonstration test.

5.6.1.3 Electrical connection.- Government-furnished incoming power from the engine generator electrical transfer switch will be connected into the power panel by the contractor. During periods when both the existing radar and the ASR-9 System are operating, power for the existing system shall be provided by the engine generator and the ASR-9 System shall operate on commercial power. A temporary switch shall be provided by the contractor for this purpose.

5.6.1.4 Installation of conduit, ductwork, power panels, and wiring.- All wiring, conduit, power panels, and ductwork required to interconnect the electronic equipment (i.e., ASR-9) shall be provided by the contractor and installed in accordance with the building plans and specifications. All wiring and conduit required to interconnect the antennas and tower to the power and electronic systems shall be provided and installed by the contractor.

5.6.1.5 Antenna placement and assembly.- The contractor shall rig, lift, place, and secure the individual components of the ASR antenna, and type FA-9764 (FAA-E-2660) or equivalent antenna (GFE) on top of the antenna tower. The antennas shall be installed level, plumb, and true to meet the requirements of the system design. If the FA-9764 signal array antenna is presently installed on the radar antenna being replaced, it shall be removed from that antenna and installed on the ASR-9 antenna.

5.6.1.6 Waveguide, Radio Frequency (RF) coaxial cable, and supporting hardware installation.- The contractor shall provide and install the ASR waveguide, connectors, adaptors, and all necessary intra-system (e.g., transmitter, receiver, antenna) coaxial cable, connector, and all necessary hardware on the rotating portion of the antenna.

5.6.1.7 Installation of signal and control interface.- The contractor shall provide, install, and connect all necessary signal and control interface cabling (wiring) between the ASR building and the antenna tower mounted equipment. The contractor shall install the conduit and shall pull all the cables into the RCJB and terminate. All wiring crossing grounding system conductors shall be in rigid steel conduit extending a minimum of 20 feet on each side of the grounding system conductors.

5.6.2 Remote sites.- System delivery; installation and tune-up shall include all remote site equipment; e.g., Cable Junction Box (CJB), modems, SCIP's, intercommunications equipment, and remote control panels. The contractor is required to install such remote site equipment in FAA facilities that are generally located at an airport air traffic control tower; specifically, an electronic equipment room and an air traffic control operations room (e.g., tower cab, tracon room). The contractor will furnish all required wireway ducts and conduit, all interconnecting cables including electrical service cable.

5.7 System alignment and checkout.-

5.7.1 Electronic equipment.- The contractor shall exercise all system controls to insure their proper operation; trace the video and digital signals through their associated equipments to the SCIP's located at the indicator site and to GFE PPI display equipment. The system shall be properly aligned and tuned to peak performance. The electronic equipment shall be thoroughly tested on-site, and parameters shall be recorded to show the optimum system capability for each channel. Both channels shall be radiated into dummy loads and they shall be left in operation continuously for 72 hours. (The ASR-9 transmitter frequency assigned by the Government will be separated from that of the presently installed ASR System so that operation of the ASR-9 will not interfere with on-going site operations.) If a system failure occurs during the test period, the test shall, at the discretion of the Government, be restarted for an additional 72 hours. Upon successful completion of the 72-hour test, the ASR-9 System will be connected to the antenna subsystem and the Government will conduct a flight inspection. The contractor shall provide the support (30 days) necessary for insuring proper equipment operation during the flight test and to assist in determining the cause of any equipment related problems encountered during the test. The (30 days) support by the contractor is required only at those locations where the ASR-9 is collocated within the same building with ASR-4/5/6's. The contractor shall be responsible for any corrective action deemed necessary as a result of any equipment related problems.

5.7.2 Airport Surveillance Radar (ASR) and beacon antenna orientation and alignment.- The contractor shall align the ASR and beacon antennas and orient the antennas to magnetic north (± 1/2 degree). The azimuth pulse generators shall be properly zeroed.

5.7.3 Mechanical and electrical equipment.- All electrical and mechanical equipment provided by the contract schedule of this specification shall be aligned and adjusted to the proper operation parameters for the installation site. All equipment shall be operated to demonstrate compliance with the requirements of this specification and the approved designs.

5.8 Cleaning.- The contractor shall deliver, to the Government, a clean radar site facility both inside and out.

5.8.1 Interior.- The contractor shall remove all trash and foreign material from the interior of the radar site buildings. Damage and finish degradation to any building, electronic subsystem interiors, or exterior surfaces, and other installed equipments resulting from transportation and installation activities shall be repaired or replaced as necessary.

5.8.2 Exterior.- All trash, litter, packing damage, and excess material shall be removed from the facility area by the contractor. The access road, parking area, facility plot, and building exteriors, etc., shall be left in the same, or better condition as existed prior to beginning work at the site under this contract.

5.9 Installation personnel.- The contractor shall use only experienced, factory trained personnel for installation supervision of field work performed. Subcontractors used by the contractor (e.g., electrical, rigging, crane service, labor, trash removal, and other miscellaneous work and services) shall be the direct responsibility of the contractor and under his direct supervision at all times.

5.10 Test equipment.- The contractor shall supply all specialized test equipment, test jigs, etc., as required for the subsystem and system testing but not required for the routine maintenance of the system. All other test equipment will be GFE on-site test equipment.

5.11 Spare parts.- The contractor shall be responsible for delivering one set of replaceable PC boards/modules during the installation and checkout phase of the program. The contractor shall maintain a log identifying all replaceable PC board/module failures that occur during the installation, checkout, and test phases of the program. Such failed units shall be repaired, refurbished, or replaced as necessary by the contractor.

5.12 Acceptance data package.- For each site specified in the contract schedule, the contractor shall furnish two complete sets of the acceptance procedures and blank acceptance data forms to the Government representative at the time of on-site delivery of equipment.

5.12.1 Preliminary acceptance data package.- The contractor shall furnish three complete acceptance data packages, to the Contracting Officer, in accordance with the contract schedule. One copy of the manuscript will be returned to the contractor with the Government's comments no later than 45 days after receipt of the preliminary acceptance data package from the contractor. The contractor shall incorporate the Government's comments and return the package for Government approval within 30 days of receipt from the Government. The Government will approve or disapprove the manuscript within 30 days of receipt by the Government from the contractor.

5.12.2 Acceptance testing.- The contractor shall perform all tests and performance checks identified in the acceptance report specified herein and in the test plan.

5.12.3 Acceptance data.-

5.12.3.1 General concept.- The on-site acceptance data package will be used as the basis for contractor demonstration of equipment compliance to contract requirements, specification requirements, and for Government acceptance of the on-site installation and test at each site. In addition, this report, certified at time of system commissioning, will be used thereafter as a maintenance reference datum for engineering analysis of system performance during periodic inspections, or following corrective action, to isolate system weak points, and to establish continuity of certified system operation in event of an aircraft accident investigation.

5.12.3.2 Integration tests.- When required by the contract, the contractor shall adapt the radar operational equipment to the parameters of the associated radar equipment in accordance with the integration test procedures. During this test, all functions and combinations of functions shall be exercised. As many interfaces and functions shall be active for this test as facility operational requirements will permit.

5.12.3.3 Acceptance record.- The acceptance record shall contain a statement of acceptance of the system complex by the Government as meeting the specification requirements and provide for signature of Government and contractor representatives. The contractor shall certify that each system complex submitted for Government acceptance meets all specification and contract requirements.

5.12.3.4 Sections.- The balance of the report shall be broken into sections as specified in the subparagraphs below. All sections of the acceptance data package shall be incorporated into one binder with provisions for easy removal and provisions to add new pages to the binder in the field.

5.12.3.4.1 Section I - site predelivery preparation.- This section shall contain the necessary procedures and a check list to insure that the site predelivery preparation has been accomplished, in accordance with the requirements of this specification and the site preparation construction package, and is ready for the installation of the electronic equipment system package.

5.12.3.4.2 Section II - mechanical and electrical installation.- This section shall contain procedures and a check list to insure that the installation of the radar electronic cabinets, antennas, waveguides, cabling (wiring), power wiring, conduit, ductwork, grounding and grounding systems, support hardware, etc., have been installed in accordance with specification requirements and good engineering practices. The acceptance of all electrical and mechanical equipment shall be subject to proper operation in accordance with all requirements of this specification and the approved designs while functioning as an ASR System at each established site.

5.12.3.4.3 Section III - operational performance.- This section shall contain thorough procedures and recording spaces for accomplishing a technical appraisal of the system operational performance including the standby power plant where installed. All essential operational parameters, adjustment data and meter readings necessary to determine acceptable performance or required for future verification for evaluation and comparison shall be included. Intermediate parameters, such as waveforms, voltages, or resistance measurements primarily used in trouble shooting and available in the instruction book are not required. Standards from applicable FAA specifications and equipment design criteria shall be specified for all waveforms, meter readings, and adjustments. In addition, data used for analyzing future system performance, such as clutter map and graphed RAG settings shall be included. The contractor shall be responsible for optimizing the system and site-adapting all system parameters.

5.12.3.4.4 Format of section III.- The information pages shall contain the following information (where applicable) for each parameter to be measured and recorded:

(a) Parameter (name, test point, etc.);

(b) Standard (standard value or setting);

(c) Procedure and test equipment type required for measurement;

(d) Equipment control settings;

(e) Space for data, photograph; and

(f) Space for initials of person making measurement and an observer.

5.12.3.4.5 Section IV - equipment inventory.- An inventory of all units installed in the system listed by FAA type number, unit description and unit serial number; a list of all spare replaceable PC boards/modules by unit description and serial number and the on-site failure data log as specified in paragraph 5.11.

6. TECHNICAL REPORTS.-

6.1 Reports.- The technical reports cited in this section are not requirements of this ASR specification. These reports are identified only as a matter of information to the contractor. The Government does not represent or guarantee that conformance to items or concepts contained within these reports will insure that the resulting product will meet specification requirements. Any reliance which the contractor places upon these technical reports is wholly at his own risk and shall not relieve him of his contractual obligation to comply with all of the requirements of this specification.

(a) D. Karp, J. R. Anderson, "Moving Target Detector (Mod II) Summary Report," Lincoln Laboratory Report ATC-95 (Nov. 3, 1981).

(b) Draft dated June 7, 1982, DOT-FAA Order 6140, System Implementation Plan, Remote Maintenance Monitoring System.

(c) Technical Report, FAA-RD-81-57, Moving Target Detector (MTD)/Airport Surveillance Radar (ASR-7) Field Evaluation, W. Goodchild, ACT-100H, Federal Aviation Administration Technical Center.

6.2 Source of documents.- Copies of these reports may be obtained from the Contracting Officer in the FAA office issuing the invitation for bids or request for proposals. Requests should fully identify material desired. Requests should cite the invitation for bids, request for proposals, or the contract involved or other use to be made of the requested material.

7. FIELD TEST AND EVALUATION.-

7.1 System evaluation criteria.- The criteria listed below may be used, but shall not be limited to the listed items, in Phase IB, Field Test and Evaluation to judge level of acceptability of ASR performance for operational use.

(1) System coverage at nose of beam 55 nm or greater for 1m^2 target.

(2) Operational SCV 42db or better.

(3) Azimuth resolution which allows aircraft separation of 1.5 nm or less up to 25 nm and 2 nm or less between 25 and 40 nm.

(4) Detection of tangential targets in the clear, over clutter, and in weather. Cancellation of fixed second-time-around targets.

(5) Interface with ARTS II, ARTS IIIA, MPS, and Mode S.

(6) Demonstrated single channel MTBF of 750 hours.

(7) Preventive maintenance shall be consistent with 1980's maintenance concept and shall be demonstrated to be one visit/month of 6 hours or less.

(8) Remote performance analysis of ASR by use of RMS in consonance with the 1980's maintenance concept.

(9) Radar spectrum criteria of assigned S-band frequency range, transmitter stability, and transmitted sidelobes is consistent with specified limits.

(10) Weather channel calibration characteristics and stability.

(11) Off-line diagnostics isolation of faults to the replaceable printed wiring board and/or module level.

(12) Minimum use of twisted pair for the total remoting requirements.

(13) Installation procedure used will minimize existing ASR downtime/interruptions.

(14) Maximum use of RMS test equipment for preventive and corrective maintenance.

(15) Meet and/or exceed the design goal of electrical power usage/conservation.

(16) Ease of insuring calibration of all RMS test equipment.

APPENDIX I

10. CONTENTS

APPENDIX II

20. GLOSSARY

20.1 Scope.- This glossary defines acronyms and abbreviated terms used in this specification.

AC	Alternating Current
ACP	Azimuth Change Pulse
A/D	Analog to Digital
APD	Azimuth Position Data
APG	Azimuth Pulse Generator
ARP	Azimuth Reference Pulse
ARTS	Automated Radar Terminal System
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
AWG	Wire Guide
BITE	Built In Test Equipment
BRITE	Bright Radar Indicator Tower Equipment
BTD	Beacon Target Detector
C&I	Correlation and Interpolation
CD	Common Digitizer
CFAR	Constant False Alarm Rate
COHO	Coherent Oscillator
CP	Circular Polarization
CPI	Coherent Processing Interval
CRT	Cathode Ray Tube
CW	Continuous Wave

DABS	Discrete Address Beacon System
D/A	Digital to Analog
dB	Decibel
dBm	Decibels above or below 1 mw = ± dBm
dBz	Weather Reflectivity Level in Decibels
DC	Direct Current
DEK	Data Entry Keyboard
DLA	Defense Logistics Agency
DP	Display Processor
f_d	Doppler Frequency
FMEA	Failure Mode Effect Analysis
FIR	Finite Impulse Response
FMECA	Failure Modes Effects and Criticality Analysis
GFE	Government Furnished Equipment
GFI	Ground Fault Interrupter
GHz	Gigahertz
Hz	Hertz
HV	High Voltage
I	In-phase Signal
IC	Integrated Circuit
ICD	Interface Control Document
ICR	Integrated Cancellation Ratio
IF	Intermediate Frequency
IOP	Input/Output Processor
I&Q	In-phase and Quadrature Phase Signal

KW	Kilowatt
LP	Linear Polarization
MDS	Minimum Discernible Signal
MHz	Megahertz
MIL	Military
MLT	Mean Level Threshold
MPCAG	Military Parts Control Advisory Group
MPS	Maintenance Processor Subsystem
MSL	Mean Sea Level
MTBF	Mean Time Between Failures
MTD	Moving Target Detector
MTI	Moving Target Indicator
MTR	Mean Time to Restore
MTTR	Mean Time to Repair
MW	Megawatt
mV	Millivolt
nm	Nautical Mile
NPAR	Nonstandard Parts Approval Request
NRL	Naval Research Laboratory
nsec	Nanosecond
NWS	National Weather Service
PC	Printed Circuit
Pd	Probability of Detection
PERT	Program Evaluation Review Technique
PFA	Probability of False Alarms

PPI	Planned Position Indicator
PPS	Pulses per Second
PRF	Pulse Repetition Frequency
PRI	Pulse Repetition Interval
PROM	Programmable Read Only Memory
PSIG	Pounds per Square Inch Gauge
Q	Quadrature Phase Signal
RADC	Rome Air Development Center
RAG	Range Azimuth Gate
RBPM	Radar Beacon Performance Monitor
RCJB	Radar Control Junction Box
RCS	Radar Cross Section
RF	Radio Frequency
RFG	Radio Frequency Generation
RFI	Radio Frequency Interference
RMA	Reliability/Maintainability/Availability
RMMS	Remote Maintenance Monitoring System
RMS	Remote Maintenance Subsystem
RPM	Revolutions per Minute
R/T	Receive/Transmit
RTN	Return to Normal
RTQC	Real-Time Quality Control
S/I	Saturation/Interference
SCFM	Standard Cubic Feet per Minute
SCIP	Surveillance and Communication Interface Processor

SCV	Subclutter Visibility
SGP	Single Gate Processing
S/N	Signal to Noise Ratio
SP	Surveillance Processor
SPI	Special Position Identifier
SRAP	Sensor Receiver and Processor
STALO	Stable Local Oscillator
STC	Sensitivity Time Control
STR	Strength of Target Report
STU	System Timing Unit
T/R	Transmit/Receive
TTG	Test Target Generator
TTL	Transistor Transistor Logic
T_O	Time at which the main RF pulse is transmitted
TRACON	Terminal Radar Control
TRACAB	Terminal Radar Cab
V	Volts
VDC	Volts Direct Current
VSWR	Voltage Standing Wave Ratio
WG	Waveguide
ZVF	Zero Velocity Filter

APPENDIX III

30. AIRPORT SURVEILLANCE RADAR (ASR-9) EXTERNAL INTERFACE.-

30.1 Scope.- This appendix describes the electrical characteristics and message formats of both the Mode S/ASR-9 interface (local) and the remote ASR-9 (Surveillance and Communications Interface Processor (SCIP)) interface to the Air Traffic Control (ATC) facility (e.g., Automated Radar Terminal System (ARTS)). It is the intent to utilize national and international standards to insure the highest degree of compatibility with both current and future equipment.

30.1.1 General design characteristics.- The following paragraphs shall be used by the contractor in the design of the various ASR-9 external interfaces. The contractor shall design all ASR-9 external interfaces as described below and submit external Interface Control Documentation (ICD) as ICD's for Government approval in accordance with the contract schedule. The following ICD's shall be submitted:

a. ASR-9 Correlation and Interpolation (C&I) processor to Mode S sensor, paragraph 30.2.1.

b. Mode S sensor to ASR-9 SP digital interface, paragraph 30.2.3.

c. Mode S sensor/ATCRBS to ASR-9 Surveillance Processor (SP) beacon target detector, paragraph 30.2.2.

d. ASR-9 sensor to ASR-9 remote SCIP, paragraph 30.2.4

e. ASR-9 SCIP to terminal computer, paragraph 30.2.5

30.2 General interface characteristics.- The interface at the local site is composed of the ASR-9 C&I processor to the Mode S sensor interface, Mode S sensor to ASR-9, and the ASR-9 to remote SCIP interface. At the remote site, the interface is composed of the ASR-9 SCIP to the terminal computer facility interface. The SCIP will contain the Display Processor (DP).

The SCIP will distribute surveillance data to the DP and surveillance and communications data to ARTS IIIA (or ARTS IIA). The DP will convert radar, beacon, and weather reports to reconstituted video suitable for presentation on the time shared displays.

30.2.1 Airport Surveillance Radar (ASR-9) Correlation and Interpolation (C&I) processor to Mode S sensor.- All output messages from the ASR-9 C&I processor are transmitted to the Mode S sensor via a high-speed (.5 MHz) dedicated communication link. These messages consist of surveillance messages and status messages. Surveillance data messages are prepared for transmission in the C&I processor, the transmission protocol is added, and the completed messages are buffered and transmitted to the Mode S sensor when the communication link is available. No error recovery procedures are implemented in the C&I processor protocol due to the high frequency of target updates. Detailed requirements are outlined in paragraph 30.3.

30.2.2 Mode S sensor/Air Traffic Control Radar Beacon System (ATCRBS) to Airport Surveillance Radar (ASR-9) Surveillance Processor (SP) Beacon Target Detector.- The ASR-9 SP Beacon Target Detector (BTD) shall receive beacon video from either the Mode S sensor (when operating in the ATCRBs backup mode) or the local ATCRBs. ATCRBs characteristics are listed in paragraphs 3.12.5.5.1 and 3.12.5.5.2.

30.2.3 Mode S sensor to Airport Surveillance Radar (ASR-9) Surveillance Processor (SP) digital interface.- The ASR-9 SP shall receive uncorrelated C&I radar target reports that have not merged with Mode S beacon reports, unmerged Mode S beacon reports, Mode S/radar reinforced reports, and ASR-9/Mode S status. Detailed requirements are outlined in paragraph 30.4 and subparagraphs.

30.2.4 Airport Surveillance Radar (ASR-9) sensor to Airport Surveillance Radar (ASR-9) remote Surveillance and Communications Interface Processor (SCIP).- All output messages from the ASR-9 sensor are transmitted to the ASR-9 SCIP via a high speed dedicated communications link. These messages consists of surveillance reports and status and alarm messages. Weather data (6-level or 2-level) is sent over a dedicated weather high speed communication link. No error recovery procedures are implemented due to the high frequency of target updates. Detailed requirements are outlined in paragraphs 30.6 and 30.11.

30.2.5 Airport Surveillance Radar (ASR-9) Surveillance and Communications Interface Processor (SCIP) to terminal computer.- The ASR-9 SCIP receives surveillance data messages from the modems and communication data from the Mode S sensor and the ARTS. The surveillance data will consist of beacon, beacon/radar reinforced, and radar-only reports.

Weather reports to the SCIP are available from one of two sources, 2-level (high and low intensity) weather reports generated at the ASR-9 C&I processor or 6-level weather reports generated at the ASR-9 6-level weather processor. The contractor shall provide the weather data format.

The SCIP will distribute the surveillance and weather data to the DP. The input format of the surveillance data shall be the Common Digitizer (CD)/ASR-9 format. Surveillance data shall also be transmitted to the ARTS.

The design shall include a serial CD format transmission capability for interfacing with ARTS IIA and a parallel Sensor Receiver and Processor (SRAP) format transmission capability for interfacing with ARTS IIIA. Detailed requirements are outlined in paragraphs 30.8 and 30.9.

30.3 Airport Surveillance Radar (ASR-9) Correlation and Interpolation (C&I) processor to Mode S sensor interface.-

30.3.1 Physical control level.-

30.3.1.1 Communication links.- There shall be dual sets of isolated data links for each C&I processor to the Mode S sensor. Each communication link shall be capable of handling the data rate generated by the ASR-9 and provide all surveillance data with a delay no greater than .14 seconds after passing the target boresight position. Data shall be transmitted over both links simultaneously provided both C&I processors are available. Data shall be transmitted at a rate of .5MHz.

30.3.1.2 Communication interface characteristics.- The electrical and mechanical characteristics of the communication interface shall conform to EIA Standard RS-449. This interface shall be a category I circuit with the balanced electrical characteristics as specified in EIA Standard RS-422.

30.3.2 Link control level.-

30.3.2.1 Procedures.- The surveillance data - communications link level protocol to be used between the C&I processor and the Mode S sensor shall be the bit-oriented Advanced Data Communication Control Procedure (ADCCP) as per ANSI x 3.66. The ADCCP provides for three classes of procedures. Only one of these is required for this application.

Asynchronous Balanced Mode (ABM) - Under such procedures, each of the two stations on a point-to-point link is a combined (primary and secondary) station. As appropriate, either of the two stations can take on the primary role (send commands), causing the other to take on the secondary role (send responses).

30.3.2.2 Information field.- The information field contains the ASR-9 C&I processor output messages. These messages consist of target reports, status, and alarm reports and are more fully discussed in paragraph 30.3.3. These reports are placed in the information field singly.

Only one report shall be allowed within each ADCCP frame. It is not permissible to split a report across two or more frames. C&I processor data output words are transmitted starting with their most significant bit.

30.3.2.3 Control functions.- The C&I processor to the Mode S sensor interface control is a simplified subset of the ADCCP control protocol, and can be considered a simplex circuit. No data retransmission shall be required from C&I under any circumstances.

30.3.3 Message level.-

30.3.3.1 Code set.- The information fields of the C&I processor transmission are constructed using transparent binary. No code structure (such as ASCII) is used.

30.3.3.2 Message format.- Two types of messages are sent from the C&I processor to the Mode S sensor, 1) target reports and 2) status and alarm reports. These are described in the following paragraphs. Additional information concerning these reports may be found in the FAA Specification FAA-E-2704 (paragraph 3.12.4.1).

30.3.3.2.1 Target report.- The target report message consisting of data as defined in paragraph 3.12.4.1(a).

30.3.3.2.2 Status and alarm report.- At least one status and alarm report shall be sent from the C&I to the Mode S sensor once per scan. If a change in ASR-9 status or alarm occurs, a status alarm report shall be transmitted from the C&I to Mode S within one scan

Neither the format nor the contents of the status and alarm report has been defined. This report and its format shall be defined by the ASR-9 contractor and incorporated into the ASR-9 System only after approval has been obtained from the Government.

30.4 Mode S merge function to the Airport Surveillance Radar (ASR-9) Surveillance Processor (SP)/scan to scan correlator interface.-

30.4.1 Physical control level.-

30.4.1.1 Communication links.- There shall be dual sets of isolated communication links, from each Mode S processor to the SP/Scan-to-Scan correlators. Each communication link shall be capable of handling the data rate generated by the Mode S and provide all surveillance data with a delay not greater than .5 seconds after antenna boresight. Data shall be transmitted over both links simultaneously provided both Mode S processors are available. Data shall be transferred at a rate of .5MHz.

30.4.1.2 Communication interface characteristics.- Same as paragraph 30.3.1.2.

30.4.2 Link control level.-

30.4.2.1 Procedures.- The surveillance data - communications link level protocol to be used between the Mode S and the ASR-9 SP/Scan-to-Scan correlator shall be the bit-oriented ADCCP as per ANSI X3.66. The ADCCP provides for three classes of procedures. Only one of these is required for this application.

Asynchronous Balanced Mode (ABM) - Under such procedures, each of the two stations on a point-to-point link is a combined (primary and secondary) station. As appropriate, either of the two stations can take on the primary role (send commands), causing the other to take on the secondary role (send responses).

30.4.2.2 Information field.- The information field contains the following message types. Each message is placed in the information field singly. The messages listed below shall include all applicable data defined in Appendix III.

a. C&I reports identical to the reports sent to Mode S. These reports represent reports that did not merge with a Mode S Beacon report. These reports are also referred to as radar only reports (Ro).

b. Mode S/radar reinforced reports which contain beacon ID field including tag bits like IDENT, reinforcement, emergencies, and code validation bits. Also contained in this report are range, azimuth, Mode 3/A, 2 & C codes, target strength, max filter PRF 1 & 2, and interpolated velocity PRF 1 & 2. These reports are also referred to as radar beacon merge messages.

c. Mode S beacon reports which contain: beacon ID field, tag bits, range, azimuth and Mode 3/A, 2 & C codes. These reports are also referred to as beacon only (Bo) messages.

d. ASR-9/Mode S status which contains the status of the ASR-9 which ASR-9 sent to Mode S and appended to this message is the status of Mode S.

30.4.2.3 Control functions.- The Mode S to the ASR-9 SP scan-to-scan correlator interface control is a simplified subset of the ADCCP control protocol, and can be considered a simplex circuit. No data retransmission shall be required from Mode S under any circumstances.

30.4.3 Message level.-

30.4.3.1 Code set.- The information fields of the Mode S transmissions are constructed using transparent binary. No code structure (such as ASCII) is used.

30.4.3.2 Message format.- There are four types of messages sent from the Mode S to the ASR-9 SP: 1) Radar-only reports, 2) Radar Beacon merge reports, 3) Beacon-only reports, and 4) ASR-9/Mode S status messages. Paragraph 30.4.2.2 contains more detail about these messages. The actual format of the data in the information field is the responsibility of the contractor and details of that format will be included in an interface control document developed by the contractor.

30.5 Mode S to Airport Surveillance Radar (ASR-9) interface.- Not used.

30.5.1 Physical control level.- Not used.

30.5.1.1 Communications links.- Not used.

30.5.1.2 Communications interface characteristics.- Not used.

30.5.2 Link control level.- Not used.

30.5.2.1 Procedures.- Not used.

30.5.2.2 Information field.- Not used.

30.5.2.3 Control functions.- Not used.

30.5.2.4 Message level.- Not used.

30.5.2.4.1 Code set.- Not used.

30.5.2.4.2 Message format.- Not used.

30.5.2.4.3 Target report.- Not used.

30.5.2.4.4 Status and alarm report.- Not used.

30.6 Airport Surveillance Radar (ASR-9) sensor to Airport Surveillance Radar (ASR-9) remote Surveillance and Communications Interface Processor (SCIP) interface.-

30.6.1 Physical control level.-

30.6.1.1 Communication links.- Each SCIP will provide the capability for two independent data links with the ASR-9 local site. When available, data shall be transmitted over both data links simultaneously with automatic selection of the data for operational use. The data links shall support surveillance data transmission in one direction only; i.e. from ASR-9 sensor to the SCIP. When only one data link is available, data shall be distributed to both SCIP's.

30.6.1.2 Communications interface characteristics.- The electrical and mechanical characteristics of the communications interface shall conform to EIA Standard RS-449. This interface shall be category I circuit with the balanced electrical characteristics as specified in EIA Standard RS-422. The data signaling rate for each surveillance data line shall be 9600 bits per second with less than 10^{-6} bit error rate on unconditioned lines. The data timing source on the Terminal Timing (TT) circuits shall be supplied by a generator within the ASR-9 sensor.

30.6.2 Link control level.-

30.6.2.1 Procedures.- The surveillance data communications link level protocol to be used between the ASR-9 sensor and the SCIP shall be common digitizer format protocol as described below:

The formats for the common output messages (beacon, search, status, search real-time quality control (RTQC), and beacon real-time quality control (RTQC), shall be defined in paragraph 30.8. In addition to these five message types, a 13-bit idle character shall be transmitted to maintain frame synchronization. The idle character shall be 0001111111111, with the bits transmitted in that (left-to-right) order. The idle character shall be transmitted at least once between successive complete messages on each data channel, and continuously when output messages are not available. In no instance shall a single message be split into parts and sent over more than one data channel.

30.6.2.2 Information field.- The field consists of beacon target reports, radar-only reports, and radar/beacon merged reports. Included in the field will be ASR-9/Mode S status and alarm information.

30.6.2.3 Control functions.- The ASR-9 sensor to SCIP interface control can be considered a simplex circuit. No data retransmission from the ASR-9 sensor to the SCIP shall be required under any circumstances.

30.6.3 Message level.-

30.6.3.1 Code set.- The information fields of the messages transmitted over the surveillance data link from ASR-9 to the SCIP are constructed using transparent binary. No code structure (such as ASCII) is used.

30.6.3.2 Message formats.- Two categories of messages are sent from the ASR-9 terminal sensor to the SCIP, 1) target reports and 2) status and alarm messages. The ASR-9 SP shall send the above two message categories to the SCIP. These reports are in CD/ASR-9 format as described in paragraph 30.8.

30.6.3.3 Target report.- The target report messages consist of the following: beacon reports, radar reports, correlated radar reports, and radar/beacon merged reports.

30.6.3.3.1 Status and alarm message.- The status and alarm message provides information concerning the operational status of the various elements of the radar and beacon sensors. The content shall be defined by the ASR-9 contractor and incorporated only after approval has been obtained from the Government.

30.7 Airport Surveillance Radar (ASR-9) Surveillance and Communications Interface Processor (SCIP) to computer interface Common Digitizer (CD)/Airport Surveillance Radar (ASR-9) serial.-

30.7.1 Physical control level.-

30.7.1.1 Communication links.- Each SCIP shall provide two isolated output serial digital interfaces, each serial digital interface shall consist of three RS 499/RS 422 communication links each operating at 9600 bits per second.

30.7.1.2 Communications interface characteristics.- The electrical and mechanical characteristics of the communications interface shall conform to EIA Standard RS 449. This interface shall be category I circuit with the balanced electrical characteristics as specified in EIA Standard RS 422. The data signaling rate for each surveillance data line shall be 9600 bits per second with less than 10^{-6} bit error rate on unconditioned lines. The data timing source on the TT circuits shall be supplied by a generator within the SCIP.

30.7.2 Link control level.-

30.7.2.1 Procedures.- The surveillance data communication link level protocol at the serial output shall be common digitizer format protocol as described in paragraph 30.6.2.1.

30.7.2.2 Information field.- Same as paragraph 30.6.2.2.

30.7.2.3 Control function.- The ASR-9 serial interface output can be considered a simplex circuit. No data retransmission from the ASR-9 serial output shall be required under any circumstances.

30.7.3 Message level.-

30.7.3.1 Code set.- The information fields of the messages transmitted over serial interface output are constructed using transparent binary. No code structure (such as ASCII) is used.

30.7.3.2 Message formats.- Same as paragraph 30.6.3.2

30.7.3.3 Target report.- Same as paragraph 30 6.3.3

30.7.3.4 Status and alarm message.- Same as paragraph 30.6.3.4

30.8 Interface Control Document (ICD) Common Digitizer (CD)/Airport Surveillance Radar (ASR-9).- Available (ICD) data to establish a baseline format for serial CD/ASR-9 interface formats.

30.8.1 Digital message formats and control.- Five message types are available from the ASR-9 to the remote SCIP. These are: 1) beacon, 2) beacon RTQC, 3) search, 4) search RTQC, and 5) status. The messages are broken into 13 bit transmission words each consisting of 12 data bits and one odd parity bit. The first transmission word in all messages contains special control flags and a message label that indicates message type. Control between messages will be maintained by the use of a synchronization word generated within the ASR-9. A minimum of one synchronization word will be used to separate each message.

30.8.2 Beacon report.- Beacon report messages are 91 bits in length and blocked into seven 13-bit fields. The fields and bits in the beacon reports have the following meanings:

Field	Bit Position/ Size (Bits)	Description
1	1(1)	Set to "0" to identify the report as a beacon target report.

Field	Bit Position/ Size (Bits)	Description
1	2-3(2)	Message Identifier - The code value "11" identifies the report as a 91-bit beacon message.
1	4(1)	Mode 2 - Mode 2 bit indicates the presence of a validated Mode 2 code when set to "1."
1	5-6(2)	Mode 3/A - code validity - =00------All replies are garbled. =01------One reply is not garbled. =10------Less than V but equal to or more than two consecutive ungarbled replies have the identical code (where V = validation value as defined in FAA-E-2704, paragraph 3.12.5.5.6.7) if $V \geq 3$; one ungarbled reply and one garbled reply have identical codes if V = 2. =11------Met validation (V) requirement of ASR-9.
1	7(1)	IDENT - The ident bit when set to "1" indicates that a validated response has been received to an identification request from ATC.
1	8(1)	Search Reinf - The radar reinforced bit indicates that a radar target report merged with the beacon report.
1	9(1)	7700 Code - The 7700 code bit indicates the presence of an emergency ATCRBS 7700 code.
1	10(1)	7600 Code - The 7600 code bit indicates the presence of an emergency ATCRBS 7600 code.
1	11(1)	Mode 3 "X" - Set to "1" for validated Mode 3 "X" responses.
1	12(1)	Always set to zero.
1	13(1)	Parity Bit.

Field	Bit Position/ Size (Bits)	Description
2	14-25(12)	Range - The range field indicates the slant range of the target in Nautical Miles (nmi). The Most Significant Bit (MSB) is equal to 32 nmi and the Least Significant Bit (LSB) is equal to 1/64 nmi.
2	26(1)	Parity Bit.
3	27-38(12)	Azimuth - The azimuth field indicates the azimuth of the target in degrees. The MSB is equal to 180 degrees (2048 Azimuth Change Pulses (ACP)) and the LSB is equal to 0.088 degrees (1 ACP).
3	39(1)	Parity Bit.
4	40-42(3)	ARTS-IIIA QUALITY - "Quality" when reported in the beacon and beacon RTQC message shall have the following meaning: When the beacon message is from "beacon only target," "quality" shall indicate the beacon runlength above threshold "SRB" (paragraph 3.12.5.5.6.10) up to seven (all beacon runlengths above seven shall be reported as seven). When the beacon message is "radar reinforced" the "quality field" shall always indicate the "quality" of radar report that merged with the beacon report.

The ARTS-IIIA radar quality shall be tentatively defined as follows; however, the selection of ASR-9 confidence and quality shall be a parameter.

ARTS-IIIA Radar Quality Level	ASR-9 Confidence and Quality
"0"	Confidence level "0" and Quality "0"
	Confidence level "0" and Quality "1"
	Confidence level "0" and Quality "2"
	Confidence level "0" and Quality "3"
"1"	Confidence level "1" and Quality "0"
	Confidence level "2" and Quality "0"
"2"	Confidence level "1" and Quality "1"

ARTS-IIIA Radar Quality Level	ASR-9 Confidence and Quality
"3"	Confidence level "1" and Quality "2" Confidence level "3" and Quality "0" Confidence level "4" and Quality "0"
"4"	Confidence level "1" and Quality "3" Confidence level "5" and Quality "0" Confidence level "4" and Quality "1"
"5"	Confidence level "3" and Quality "1" Confidence level "4" and Quality "2" Confidence level "5" and Quality "1"
"6"	Confidence level "3" and Quality "2" Confidence level "4" and Quality "3" Confidence level "5" and Quality "2"
"7"	Confidence level "3" and Quality "3" Confidence level "5" and Quality "3"

Field	Bit Position/ Size (Bits)	Description
4	43(1)	Discrete - The discrete bit (when set to "1") indicates the presence of a discrete code.
4	44(1)	Mode 2 "X" - Set to "1" for validated Mode 2 "X" responses.
4	45-49(5)	Beacon hit count (0-31).
4	50-51(2)	Mode C - code validity - =00------All replies are garbled. =01------One reply is not garbled. =10------Less than V but equal to or more than two consecutive ungarbled replies have the identical code (where V = validation value as defined in FAA-E-2704, paragraph 3.12.5.5.6.7) if V $\geq$ 3; one ungarbled reply and one garbled reply have identical codes if V = 2. =11------Met validation (V) requirement of ASR-9.
4	52(1)	Parity Bit.

Field	Bit Position/ Size (Bits)	Description
5	53-64(12)	Mode 3/A Code - This field contains the Mode 3/A code which uniquely identifies the beacon target.
5	65(1)	Parity Bit.
6	66-77(12)	Mode 2 Code - This field contains the Mode 2 code which uniquely identifies the beacon target.
6	78(1)	Parity Bit.
7	79(1)	Sign - The sign bit is associated with the Mode C altitude. If the bit is set to zero, the sign is positive and if set to "1", the sign is negative.
7	80-90(11)	Mode C Altitude - This field contains the Mode C altitude. The MSB is equal to 102,400 ft and LSB is equal to 100 ft. If bit 79 is set, a negative Mode C altitude shall be reported in two's complement.
7	91(1)	Parity Bit.

30.8.3 Beacon Real-Time Quality Control (RTQC) Report.- Beacon RTQC report messages are 91 bits in length and are blocked into seven 13-bit fields. The fields and bits in the beacon RTQC report have the following meaning:

Field	Bit Position/ Size (Bits)	Description
1	1(1)	Set to "1" to identify the report as a beacon RTQC report.
1	2-3(2)	Message Identifier - The code value 11 identifies the report as a 91-bit beacon message.
1	4(1)	Mode 2 - Mode 2 bit indicates the presence of a validated Mode 2 code when set to "1."

Field	Bit Position/ Size (Bits)	Description
1	5-6(2)	Mode 3/A - code validity - =00------All replies are garbled. =01------One reply is not garbled. =10------Less than V but equal to or more than two consecutive ungarbled replies have the identical code (where V = validation value as defined in FAA-E-2704, paragraph 3.12.5.5.6.7) if V $\geq$ 3; one ungarbled reply and one garbled reply have identical codes if V = 2. =11------Met validation (V) requirement of ASR-9.
1	7(1)	IDENT - The ident bit when set to "1" indicates that a validated response has been received to an identification request from ATC.
1	8(1)	The radar reinforced bit indicates that a radar target report merged with a beacon report.
1	9(1)	7700 Code - Always set to "0."
1	10(1)	7600 Code - Always set to "0."
1	11(1)	Mode 3 "X" - Set to "1" for validated Mode 3 "X" responses.
1	12(1)	Antenna synchronization data (sector marks) - The antenna synchronization bit when set to "1" indicates that this message is to be used to synchronize the SCIP and ATC computer (ARTS-IIA and ARTS-IIIA) with the position of radar antenna. If bit 12 is set to "1," all RTQC data shall be set to zero except bits - 1, 2-3, 12, the azimuth field, and parity.
1	13(1)	Parity Bit.
2	14-25(12)	Range - The range field indicates the slant range of the target in nmi. The MSB is equal to 32 nmi and the LSB is equal to 1/64 nmi.
2	26(1)	Parity Bit.

Field	Bit Position/ Size (Bits)	Description
3	27-38(12)	Azimuth - The azimuth field indicates the azimuth of the beacon RTQC targets or the sector marks in degrees. The MSB is equal to 180 degrees (2048 ACP's) and the LSB is equal to 0.088 degrees (1 ACP).
3	39(1)	Parity Bit.
4	40-42(3)	ARTS-IIIA Quality - "Quality" when reported in the beacon and beacon RTQC message shall have the following meaning: When the beacon message is from "beacon only target," "quality" shall indicate the beacon runlength above threshold "SRB" (paragraph 3.12.5.5.6.10) up to seven (all beacon runlengths above seven shall be reported as seven). When the beacon message is "radar reinforced" the "quality field" shall always indicate the "quality" of radar report that merged with the beacon report.

The ARTS-IIIA radar quality shall be tentatively defined as follows; however, the selection of ASR-9 confidence and quality shall be a parameter.

ARTS-IIIA Radar Quality Level	ASR-9 Confidence and Quality
"0"	Confidence level "0" and Quality "0" Confidence level "0" and Quality "1" Confidence level "0" and Quality "2" Confidence level "0" and Quality "3"
"1"	Confidence level "1" and Quality "0" Confidence level "2" and Quality "0"
"2"	Confidence level "1" and Quality "1"
"3"	Confidence level "1" and Quality "2" Confidence level "3" and Quality "0" Confidence level "4" and Quality "0"
"4"	Confidence level "1" and Quality "3" Confidence level "5" and Quality "0" Confidence level "4" and Quality "1"

ARTS-IIIA Radar Quality Level	ASR-9 Confidence and Quality
"5"	Confidence level "3" and Quality "1" Confidence level "4" and Quality "2" Confidence level "5" and Quality "1"
"6"	Confidence level "3" and Quality "2" Confidence level "4" and Quality "3" Confidence level "5" and Quality "2"
"7"	Confidence level "3" and Quality "3" Confidence level "5" and Quality "3"

Field	Bit Position/ Size (Bits)	Description
4	43(1)	Discrete - The discrete bit (when set to "1") indicates the presence of a discrete code.
4	44(1)	Mode 2 "X" - Set to "1" for validated Mode 2 "X" responses.
4	45-49(5)	Beacon hit count (0-31).
4	50-51(2)	Mode C validity - =00------All replies are garbled. =01------One reply is not garbled. =10------Less than V but equal to or more than two consecutive ungarbled replies have the identical code (where V = validation value as defined in FAA-E-2704, paragraph 3.12.5.5.6.7) if V $\geq$ 3; one ungarbled reply and one garbled reply have identical codes if V = 2. =11------Met validation (V) requirement of ASR-9.
4	52(1)	Parity Bit.
5	53-64(12)	Mode 3/A Code - This field contains the Mode 3/A code which uniquely identifies the beacon target.
5	65(1)	Parity Bit.

Field	Bit Position/ Size (Bits)	Description
6	66-77(12)	Mode 2 Code - This field contains the Mode 2 code which uniquely identifies the beacon target.
6	78(1)	Parity Bit.
7	79(1)	Sign - The sign bit is associated with the Mode C altitude. If the bit is set to zero, the sign is positive and if set to "1", the sign is negative.
7	80-90(11)	Mode C Altitude - This field contains the Mode C altitude. The MSB is equal to 102,400 ft and LSB is equal to 100 ft. If bit 79 is set, a negative Mode C altitude shall be reported in two's complement.
7	91(1)	Parity Bit.

30.8.4 Search report.- Search reports that cannot be merged with beacon reports are 52 bits in length and are blocked into four 13-bit fields. The fields and bits in the search report have the following meaning:

Field	Bit Position/ Size (Bits)	Description
1	1(1)	Set to "0"to identify the report as a search target report.
1	2-10(9)	Message Identifier - The code value 001101100 identifies the reports as a 52-bit search message
1	11(1)	Always set to zero.
1	12(1)	Always set to zero.
1	13(1)	Parity Bit.
2	14-25(12)	Range - The range field indicates the slant range of the target in nmi. The MSB is equal to 32 nmi and the LSB is equal to 1/64 nmi.
2	26(1)	Parity Bit.

Field	Bit Position/ Size (Bits)	Description
3	27-38(12)	Azimuth - The azimuth field indicates the azimuth of the target in degrees. The MSB is equal to 180 degrees (2048 ACP's) and the LSB is equal to 0.088 degrees (1 ACP).
3	39(1)	Parity Bit.
4	40-41(2)	Quality.
4	42-44(3)	Confidence.
4	45-46(2)	Tracking Eligibility - =00 Radar target reports (vehicular traffic) that are to be used for display only. This target report is not eligible for track initiation or correlation with existing track. =01 Radar target reports eligible for track correlation only. =10 Radar target reports eligible for track initiation and correlation.
4	47-49(3)	ARTS-IIIA radar quality.

The ARTS-IIIA radar quality shall be tentatively defined as follows; however, the selection of ASR-9 confidence and quality shall be a parameter.

ARTS-IIIA Radar Quality Level	ASR-9 Confidence and Quality
"0"	Confidence level "0" and Quality "0" Confidence level "0" and Quality "1" Confidence level "0" and Quality "2" Confidence level "0" and Quality "3"
"1"	Confidence level "1" and Quality "0" Confidence level "2" and Quality "0"
"2"	Confidence level "1" and Quality "1"
"3"	Confidence level "1" and Quality "2" Confidence level "3" and Quality "0" Confidence level "4" and Quality "0"
"4"	Confidence level "1" and Quality "3" Confidence level "5" and Quality "0" Confidence level "4" and Quality "1"

ARTS-IIIA Radar Quality Level	ASR-9 Confidence and Quality
"5"	Confidence level "3" and Quality "1" Confidence level "4" and Quality "2" Confidence level "5" and Quality "1"
"6"	Confidence level "3" and Quality "2" Confidence level "4" and Quality "3" Confidence level "5" and Quality "2"
"7"	Confidence level "3" and Quality "3" Confidence level "5" and Quality "3"

Field	Bit Position/ Size (Bits)	Description
4	50(1)	Always set to zero.
4	51(1)	Correlation Bit - Set to "1" if the target is correlated and set to zero if the target is uncorrelated.
4	52(1)	Parity Bit.

30.8.5 Search Real-Time Quality Control (RTQC).- Search RTQC report messages are 52 bits in length and are blocked into four 13-bit fields. The fields and bits in the search RTQC report have the following meaning:

Field	Bit Position/ Size (Bits)	Description
1	1-10(10)	Message Identifier - The code value 1001001000 identifies the report as a 52-bit search RTQC message.
1	11(1)	Always set to zero.
1	12(1)	Antenna synchronization data (sector marks) - The antenna synchronization bit when set to "1" indicates that this message is to be used to synchronize the SCIP and ATC computer (ARTS-IIA and ARTS-IIIA) with the position of radar antenna. If bit 12 is set to "1," all RTQC data shall be set to zero except bits associated with the message identifier, the azimuth field, and parity.
1	13(1)	Parity bit.

Field	Bit Position/ Size (Bits)	Description
2	14-25(12)	Range - The range field indicates the slant range of the search target in nmi. The MSB is equal to 32 nmi and the LSB is equal to 1/16 nmi.
2	26(1)	Parity bit.
3	27-38(12)	Azimuth - The azimuth field indicates the azimuth of the search target or sector mark in degrees. The MSB is equal to 180 degrees (2048 ACP's) and the LSB is equal to 0.088 degrees (1 ACP).
3	39(1)	Parity bit.
4	40-41(2)	Quality.
4	42-44(3)	Confidence.
4	45-46(2)	Tracking eligibility =00 Radar target reports (vehicular traffic) that are to be used for display only. This target report is not eligible for track initiation or correlation with existing track. =01 Radar target reports eligible for track correlation only. =10 Radar target reports eligible for track initiation and correlation.
4	47-49(3)	ARTS-IIIA radar quality.

The ARTS-IIIA radar quality shall be tentatively defined as follows; however, the selection of ASR-9 confidence and quality shall be a parameter.

ARTS-IIIA Radar Quality Level	ASR-9 Confidence and Quality
"0"	Confidence level "0" and Quality "0" Confidence level "0" and Quality "1" Confidence level "0" and Quality "2" Confidence level "0" and Quality "3"
"1"	Confidence level "1" and Quality "0" Confidence level "2" and Quality "0"
"2"	Confidence level "1" and Quality "1"

ARTS-IIIA Radar Quality Level	ASR-9 Confidence and Quality
"3"	Confidence level "1" and Quality "2" Confidence level "3" and Quality "0" Confidence level "4" and Quality "0"
"4"	Confidence level "1" and Quality "3" Confidence level "5" and Quality "0" Confidence level "4" and Quality "1"
"5"	Confidence level "3" and Quality "1" Confidence level "4" and Quality "2" Confidence level "5" and Quality "1"
"6"	Confidence level "3" and Quality "2" Confidence level "4" and Quality "3" Confidence level "5" and Quality "2"
"7"	Confidence level "3" and Quality "3" Confidence level "5" and Quality "3"

Field	Bit Position/ Size (Bits)	Description
4	50(1)	Always set to zero.
4	51(1)	Correlation Bit - Set to "1" if the target is correlated and set to "0" if the target is uncorrelated.
4	52(1)	Parity Bit.

30.8.6 Status.- The status message provides information concerning the operational status of the various elements of the radar and Mode S sensors. This message is 52 bits in length and are blocked into four 13-bit fields. The bit definitions for the bits in the first field are shown below. The bit definitions for the remaining three fields are not defined and will be included once they become available.

Field	Bit Position/ Size (Bits)	Description
1	1(1)	Test Bit - The test bit is set to "1" if the report is a test status message.
1	2-10(9)	Message Identifier - The code value 000110000 identifies the report as a 52-bit status message.

Field	Bit Position/ Size (Bits)	Description
1	11(1)	Always set to zero.
1	12(1)	Always set to zero.
1	13(1)	Parity Bit.

30.8.7 Idle.- A minimum of at least one 13-bit "idle character" will be transmitted between output messages over each modem channel to maintain frame synchronization. The "idle character" will be 0001111111111 (even parity) with the bits transmitted in the left to right order depicted above. The "idle character" will be transmitted continuously (over each channel) when output messages are not available.

30.9 Interface Control Document (ICD) Sensor Receive and Processor (SRAP)/ Airport Surveillance Radar (ASR-9).- Available (ICD) data to establish a baseline format for SRAP/ASR-9 parallel interface format.

30.9.1 Physical control level.- Each SCIP shall provide two isolated output parallel digital interfaces, each parallel digital interface shall transmit 30-bit words plus two bits for parity to Input/Output Processor (IOP) (parts of ARTS-3A). The parallel interface and related interfaces shall be capable of transferring 10,000 words per second.

30.9.2 Communication interface characteristics.- Each input channel of the IOP shall function as specified herein. IOP shall recognize each "1" received on any control line by detecting the change in voltage level of the signal. It shall not recognize another "1" on that control line until its circuitry has been reset by a change in the voltage level of the signal in the opposite direction (a "0"). All the input signals shall be logically detected as a transition. The input logic of the SCIP's parallel interface shall not detect the transition, but rather the actual state of the signal on the line.

When interconnected as shown in figure 30-1, the IOP and SCIP shall be capable of transferring data from the SCIP to the IOP as specified herein. Input channel control lines shall function as specified in table 30-1.

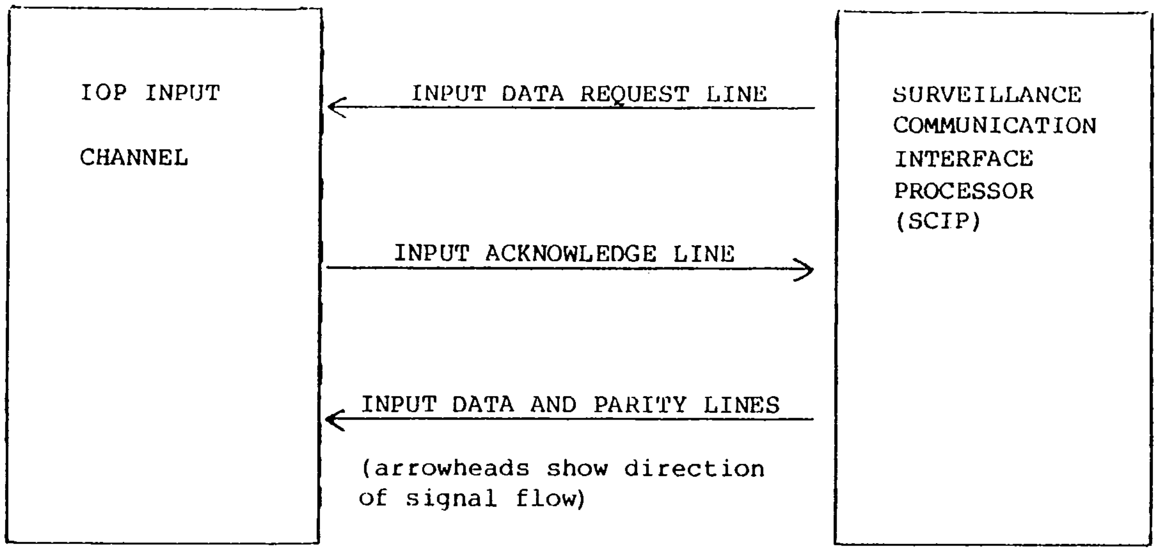


FIGURE 30-1. Input Communication Interface

TABLE 30-1 - FUNCTION OF INPUT CHANNEL CONTROL LINES

NAME OF LINE	DIRECTION OF SIGNAL	FUNCTION
Input Data Request (IDR) Line	SCIP TO IOP	Set condition indicates that the SCIP equipment has placed a word of data available to the IOP on the Input Data Lines of that channel.
Input Acknowledge Line	IOP to SCIP	Set condition indicates that the IOP has read the Input Data Lines of that channel.

Transfer of Input Data:

The IOP and SCIP shall transfer data as follows:

a. The SCIP shall place a word of data on the Input Data Lines before or not later than 100 ns after the IDR is set (see figure 30-2).

b. The SCIP shall set the Input Data Request Line (to indicate that a word of data is on the Input Data Lines).

c. In accordance with internal priority the IOP shall detect the setting of the Input Data Request Line.

d. The IOP shall read the data word which is on the Input Data Lines.

e. The IOP shall set the Input Acknowledge Line (indicating that it has read the data word on the Input Data Lines).

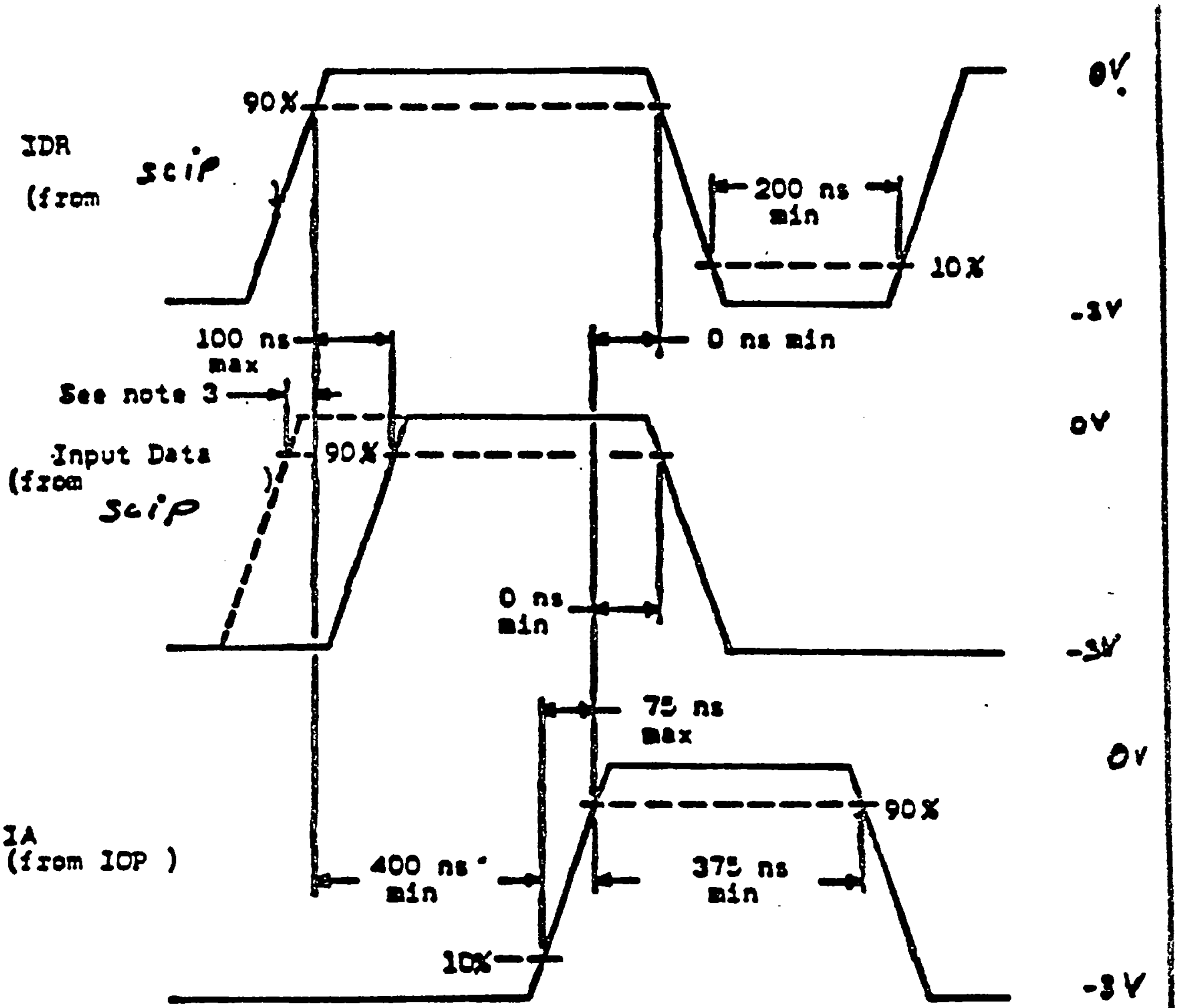
f. The SCIP shall detect the setting of the Input Acknowledge Line. (The SCIP may clear the Input Data Request Line any time after detecting the setting of the Input Acknowledge Line, but it must clear the Input Data Request before the IOP will recognize the next Input Data Request).

g. The IOP shall clear the Input Acknowledge Line before it reads the next word on the Input Data Lines.

The IOP and SCIP shall repeat this sequence for each successive word of data until they have transferred the block of data specified by the Input Buffer Control Words.

Signal Timing:

Durations of signals and timing between signals in any communication sequences shall comply with the applicable limits specified herein. These limits are neither absolute nor necessarily typical, but rather they are minimums that denote the following dual requirements:



Notes:

1. Both IDR and EIR shall not be set together at any time.
2. Upper levels are logical one; lower levels are logical zero.
3. Input data may be raised any time before the IDR.

FIGURE 30-2. Signal Timing

a. Neither the initiation nor the termination of any control or data signal shall occur sooner than specified herein.

b. Each equipment shall be capable of recognizing data and control signals that occur at the times or any time later than the times specified and that exist for any duration equal to or greater than the durations specified herein.

The IOP input shall function in accordance with the signal timing specified in figure 30-2.

Electrical Characteristics

The IOP interface shall be characterized by nominal values of 0 and -3 volts to represent the binary "one" and "zero" states, respectively. The electrical characteristics shall be as specified in the following subparagraphs.

Input/Output Processor (IOP) Input Amplifier:

Each IOP input amplifier circuit shall have the following characteristics:

a. The maximum steady state current drawn from a line by an input circuit shall not exceed 21 milliamperes when the input is between zero volt and -0.5 volts.

b. The input circuit shall be such if the input wire is disconnected, the effect will be as though a "zero" were present at the input.

c. The threshold level distinguishing the "one" state shall be a voltage level at the input more positive than -1.1 volts. The threshold level distinguishing a "zero" state shall be more negative than -2.5 volts.

d. The equivalent circuit as seen across the input line shall be as specified in figure 30-3. The signal shall be transmitted through twisted pair and terminated in a 160 ohm impedance differential amplifier for common mode noise rejection.

e. All external equipment shall adequately resynchronize all control signals; i.e., signals other than data. Resynchronization shall be accomplished by sensing the control signal transition from the "zero" to the "one" state.

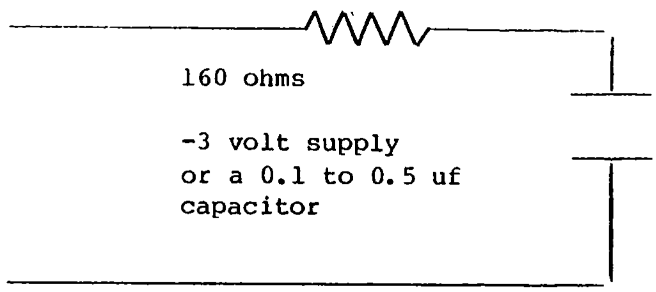


FIGURE 30-3 - Equivalent Input Line Circuit

TABLE 30-2 - Input/Output Processor (IOP) Connector Pin Assignment

*SIGNAL	RETURN	INPUT CHANNEL CONNECTOR
B1	--	Shield Ground
B3	A3	Lower Half Word Parity
B4	A4	Upper Half Word Parity
B5	A5	Input Data Request
B6	A6	Input Data Acknowledge
D1	C1	Data Bit 0
D12	C12	Data Bit 11
G1	H1	Data Bit 12
G12	H12	Data Bit 23
J1	K1	Data Bit 24
J6	K6	Data Bit 29

*Each signal and the corresponding return, shield ground, require a twisted pair.

DRAWINGS
Univac

7084908	Connector, Plug, Electrical
7117309	Connector Assembly, Electrical - 120 Pin
7902244	Connector, Electrical Receptacle-Plate, Male 120 Contracts

Surveillance and Communications Interface Processor (SCIP) Output Drivers:

Each SCIP line driver circuit shall have the following characteristics when driving a line with any characteristics impedance between 120 ohms and 180 ohms:

a. The binary "one" state of a Data Line Driver shall be zero volts to -0.5 volts at the terminals of the equipment under all condition.

b. The binary "zero" state of a Data Line Driver shall be -3.0 to -4.5 volts at the terminals of the equipment.

*c. In the binary "one" state, the Data Line Driver circuit can provide 25 milliamperes current to the line and the control line driver can provide 37 milliamperes. The "zero" state of a control line driver shall be -3.0 to -5.5 volts at the terminals of the equipment.

d. The waveform of any output circuit applied to any line shall have the following characteristics:
   (1) The minimum rise time shall be 2 nanoseconds.
   (2) The maximum rise time shall be 75 nanoseconds.

e. A circuit used to drive a control line shall present a resistance of 100,000 ohms or more from ground to the line when power is removed. Applying or removing power shall not cause spurious signals on any control lines.

*Each data line driver circuit that drivers more than one line (four data lines per circuit in the IOP) shall have proportionally more capability than specifically here.

Surveillance and Communications Interface Processor (SCIP)/Input/Output Processor (IOP) Physical Interface:

The SCIP shall provide the means to transmit the surveillance data messages to the ARTS-IIIA IOP. For this purpose, the contractor can utilize the in-place 120 conductor cable between the SRAP and the IOP by disconnecting the SRAP. The in-place SRAP-to-IOP cable, connectors and pin connector assignment is in accordance with table 30-2. The maximum transmission distance shall be 200 feet.

SRAP/Airport Surveillance Radar (ASR-9) Output Format:

The SCIP output shall be determined based on the following priority:

1. Error messages
2. Sector messages
3. Target reports

The SRAP/ASR-9 output format follows:

1. BEACON REPORT

<table>
<tr><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>P 2</td><td>P 1</td><td colspan="3">N</td><td colspan="2">RNG</td><td>T</td><td colspan="3">Q</td><td colspan="6">ID</td><td colspan="3">N</td><td colspan="12">RANGE</td></tr>
<tr><td>P 2</td><td>P 1</td><td colspan="3">N</td><td colspan="12">AZIMUTH</td><td colspan="3">N</td><td colspan="12">CODE</td></tr>
<tr><td>P 2</td><td>P 1</td><td colspan="3">N</td><td>Rr</td><td colspan="11">ALTITUDE</td><td colspan="8">BHC</td><td>R</td><td>X</td><td>S</td><td colspan="2">Vc</td><td colspan="2">Va</td></tr>
</table>

N	Not Used
P1	Lower Half Word Parity
P2	Upper Half Word Parity
*BHC	Beacon Hit Count
ID	Message ID = 010 110
*Q	Quality of Beacon or Quality of Radar When Radar Reinforced Set (Bit 22 Set Indicates Radar Reinforced)
T	Test Target
Range	12 LSB's of Target Range (LSB = 1/64 nm)
RNG	
Azimuth	LSB = 1 ACP, 4096 ACP's Per Scan
3/A code	0000 -7777 (OCTAL) Code Value
Altitude	Mode C Altitude, LSB = 100 Feet Sign (Bit 25), One's Complement = 1777 - Illegal Altitude Code Reported = 1776 - All Zero Altitude Code Reported
Vc	Mode C Validity
S	SPI
R	Ring Target Indicator, 1 = Ring, 0 = Normal
Rr	Radar Reinforced
X	Code Bit Indicating unmanned aircraft or Undefined

2. RADAR REPORT

<table>
<tr><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>P 2</td><td>P 1</td><td colspan="3">N</td><td colspan="2">R</td><td>T</td><td colspan="3">Q</td><td colspan="6">ID</td><td colspan="3">N</td><td colspan="12">RANGE</td></tr>
<tr><td>P 2</td><td>P 1</td><td colspan="3">N</td><td colspan="12">AZIMUTH</td><td colspan="15">N</td></tr>
</table>

N	Not Used
P1	Lower Half Word Parity
P2	Upper Half Word Parity
ID	Message ID = 001 010
*Q	Report Quality
T	Test Target
Range	12 LSB's of Target Range (LSB = 1/64 nm)
R	Set to 0's
Azimuth	LSB = 1 ACP, 4096 ACP's Per Scan

3. SECTOR MARK

<table>
<tr><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>P 2</td><td>P 1</td><td colspan="3">N</td><td>C</td><td colspan="5">SECTOR</td><td colspan="6">ID</td><td colspan="15">N</td></tr>
</table>

N	Not Used
P1	Lower Half Word Parity
P2	Upper Half Word Parity
ID	Message ID = 001 101
Sector	0-37 corresponding to Azimuth Sector 0-31 (DECIMAL)
C:	1 Combined Radar and Beacon Sector Mark
	0 Radar or Beacon-Only Sector Mark

4. ALARMS

31	30	29 28 27	26 25 24 23	22 21	20 19 18 17 16 15	14 13 12	11 10 9 8 7 6 5 4 3 2 1 0
P 2	P 1	N	ALARMS	SCE	ID	N	ALARMS

N	Not Used
P1	Lower Half Word Parity
P2	Upper Half Word Parity
Alarms	To Be Determined
*SCE	Identifies the Subsystem Generating The Alarm Word
ID	Message ID = 110 110

<u>30.10 Mode S/Automated Radar Terminal System (ARTS) communication interface</u>.-

<u>30.10.1 Surveillance and Communications Interface Processor (SCIP) to Mode S/Automated Radar Terminal System (ARTS) interconnection</u>.- Each SCIP shall provide interface connections for up to 20 twisted pairs.

<u>30.11 Airport Surveillance Radar (ASR-9) weather channel to remote Surveillance and Communications Interface Processor (SCIP) interface</u>.-

<u>30.11.1 Message formats</u>.- The ASR-9 weather data message format, including control protocols, for both 2-level weather and 6-level weather shall be described by the contractor in an interface control document as required by the contract schedule.

APPENDIX V

50. AUTOMATED RADAR TERMINAL SYSTEM (ARTS) III/ATCBI INTERFACE DATA.-

50.1 Scope.- This appendix describes the electrical characteristics of the beacon video interface with the ARTS III and the ARTS III beacon video characteristic as processed by the Data Acquisition Subsystem (DAS), reference figure 50-1. Additionally, the alternate beacon video characteristics (DAS backup) are described for the noncommon (1212) decoder output.

50.2 Automated Radar Terminal System (ARTS) III Beacon Video Characteristics.- The DAS accepts signals from the beacon interrogator (normally from 75 ohm landline) and converts this data digital form, suitable for use in the Data Processing Subsystems. In addition, the DAS also provides partially-decoded beacon video to the Data Entry and Display Subsystem (DEDS) via a beacon video channel. The partially decoded video has the following characteristics:

Output Impedance	75 ohms
Video Amplitude	2.5V $\pm$ 1.5V
Pulse Width	0.475 $\pm$ 0.25 usec

The DAS analog beacon video output to the DEDS is the composite beacon video (mixed video and mode pulses) from the coaxial cable or RML.

50.3 Air Traffic Control Beacon Interrogator (ATCBI) Video Characteristics.- The normal ARTS IIIA system has retained certain ATCBI-3 indicator site equipment, reference figure 50-2. This configuration normally has two noncommon decoders (1212 decoders) while some facilities still require a ten noncommon decoder configuration. The general description of the ATCBI-3 indicator site equipment and video characteristics are as follows:

(a) General.- The indicator site equipment receives triggers, reply video, and readback signals from the transmitter site equipment. These signals are decoded and processed for presentation on the appropriate indicating equipment. A control unit at each operator's position allows the operator to select the type of decoded video to be displayed at his position. A rapid readout capability of the equipment is no longer used. Control circuits are also provided to allow remote control and operational monitoring of the transmitter site equipment (normally not used at long range radar sites). The decoding equipment is divided by function into common and noncommon equipments.

(b) Common Racks

(1) Common rack Channel 1 and common rack Channel 2 each contain a common decoder A, common decoder B, decoder control power supply, and common circuitry power supply. Decoder outputs of either channel may be selected, and the other channel becomes

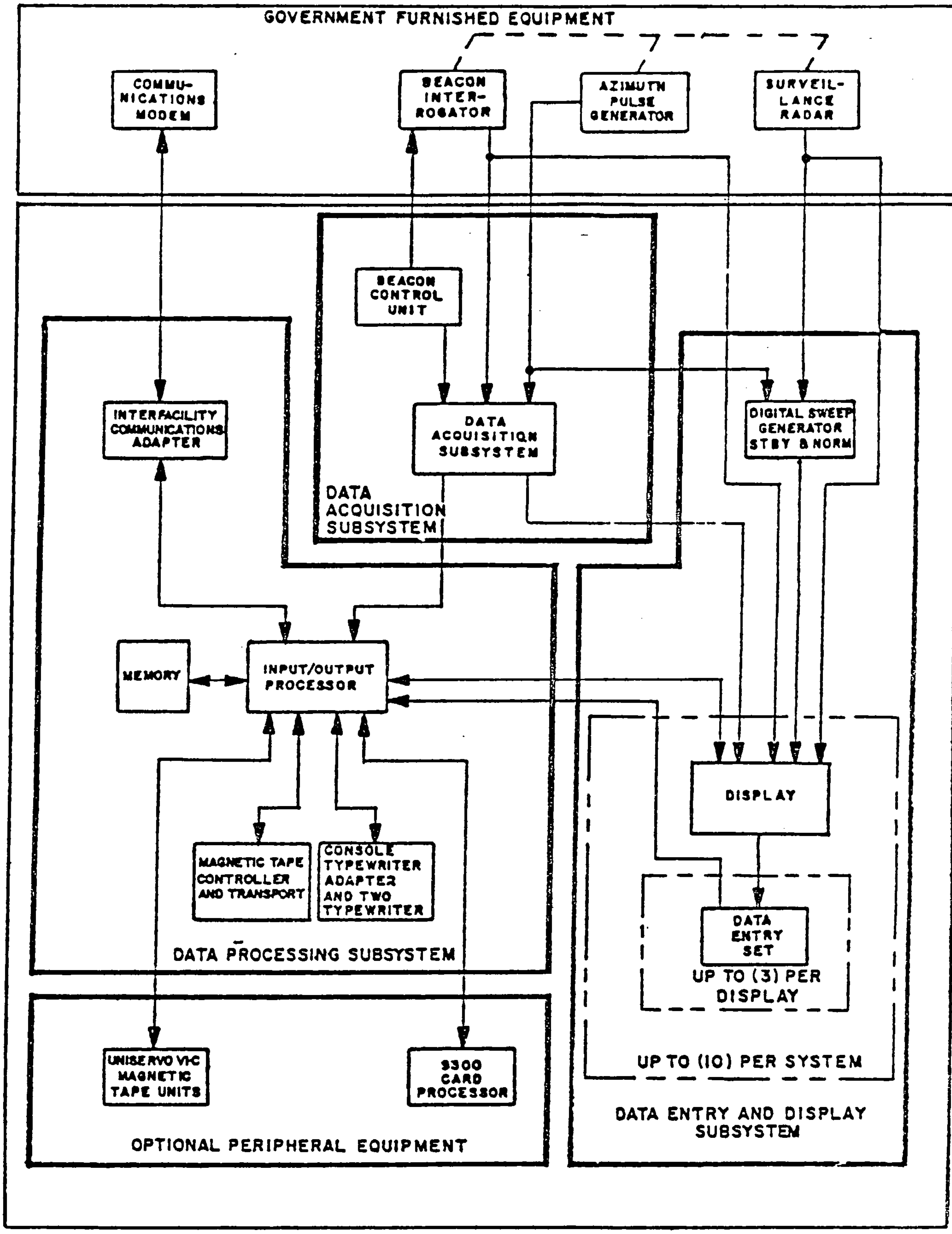


Figure 50-1
Single Beacon ARTS III System

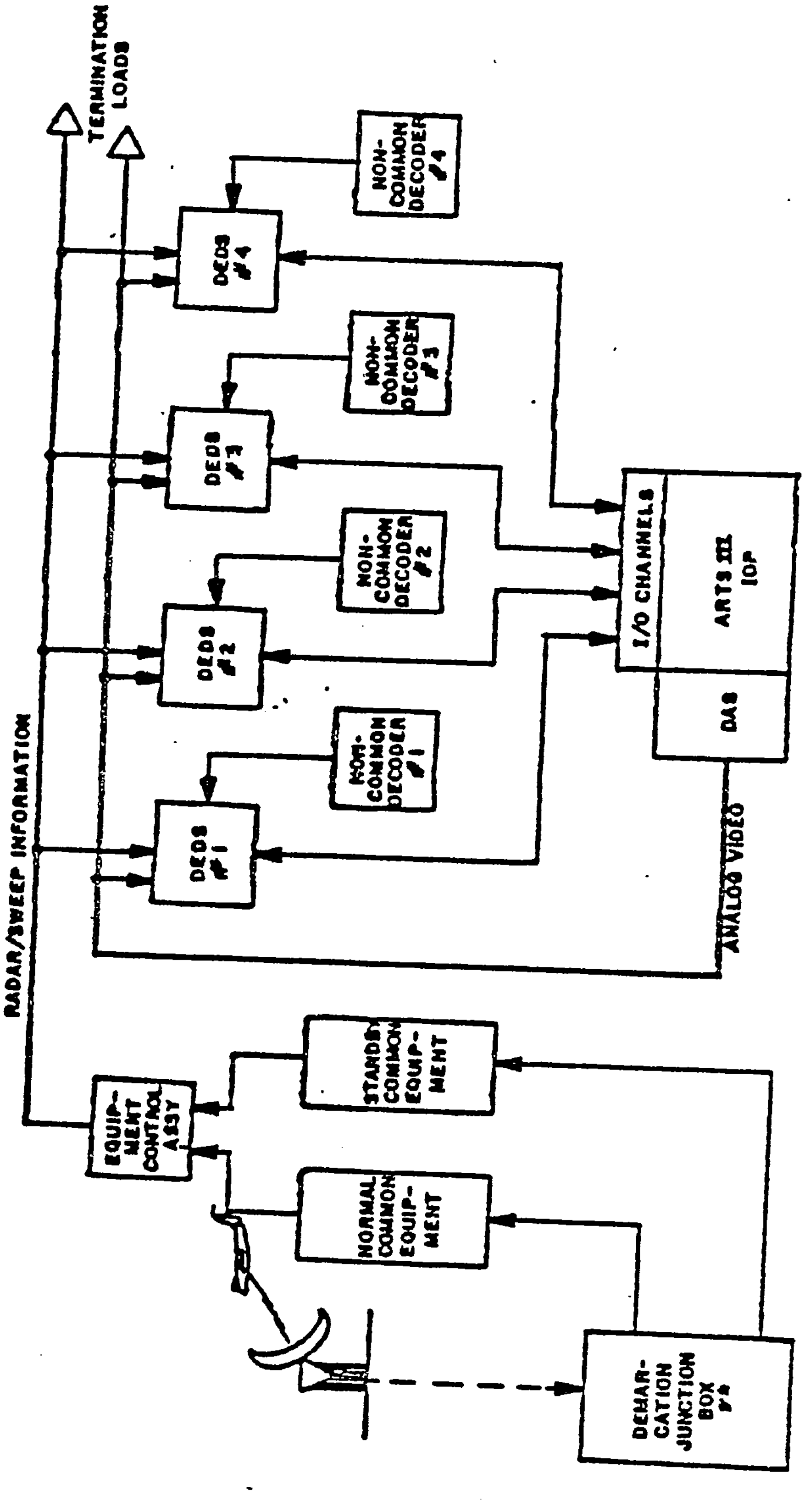


Figure 50-2
DEDS Block Diagram

the standby channel. Selection of common decoders is made by the common circuit transfer switch mounted in common rack Channel 2. A spare transfer switch is also provided. Included in common rack Channel 1 is a line compensating network assembly containing five relays (used with the readback signals) and two line compensating networks. One compensating network is a spare, and the other network may be used to compensate input signals. The signals are then routed to the inputs of common decoder A equipment in Channels 1 and 2. Common decoder A contains circuits for compensation of video, triggers separation, mode decoding, series to parallel decoding of coded replies, and detecting and indicating emergency replies. Outputs of common decoder A are routed to the common circuit transfer switch for connection to the noncommon racks.

(2) Common decoder B further processes delayed raw video from common decoder A to provide raw video, all aircraft video, and common system video outputs. The rapid readout circuits in common decoder B are not used. The outputs of common decoder B are routed to the common circuit transfer switch for connection to the noncommon racks. Selection of the active decoder control power supply and resetting of the protective circuits are accomplished at the common circuitry transfer switch panel.

(3) The common circuitry transfer switch is used to connect the common decoder outputs of either Channel 1 or Channel 2 to the noncommon decoders. Chapter 34 of AF P 6360.1, Radar Facilities and Equipment Modification Handbook-Radar Beacon, describes a modification which allows one standby common decoder to be switched into any one of three separate ATCBI-3 decoder systems. Three standby common racks would normally be provided with three complete systems; however, after the modification only one standby common rack is required for three systems.

(c) Noncommon Racks.- The indicator site equipment was designed to supply as many as 11 operator positions, each requiring a noncommon decoder. Some systems have been modified to allow additional operator positions with fewer uncommon decoders (reference paragraph 19.e). A code multiplex modification may be used to enable decoding of four codes on each modified channel of a noncommon decoder. A noncommon rack provides mounting space for two noncommon decoder and power supplies. The noncommon decoders receive the signals from the common decoders and supply the output videos selected on the associated control box. The output of the noncommon decoder is a single video line which carries the selected videos to the display equipment. Types of videos that may be displayed include all aircraft, common system, raw video, select single pulse, select pulse pair, identification stretched pulse, and emergency stretched pulse pair. Chapter 44 of AF P 6360.1 describes a modification that provides an additional pulse for Video Channel 1.

(d) Signal Inputs.

(1) Coaxial Cable.

(a) Video Amplitude: IV minimum.

(b) Trigger Amplitude: 3V minimum.

(2) Remote Microwave Link.

(a) Video Amplitude: 1 to 4V (2V nominal).

(b) Trigger Amplitude: 20V minimum.

(e) Decoding Feature.

(1) Raw Video: A slash for each pulse of reply.

(2) All Aircraft.

(a) Common System Replies: Single slash.

(b) Other Replies: A slash for each pulse of reply.

(3) Common Systems.

(a) Common System Replies: Single slash.

(b) Other Replies: No output.

(4) Select Decode (10 switches).

(a) SEL Position: Single slash for selected code.

(b) ID Position: Double slash for selected code.

(5) Identification Reply: Bloom slash.

(6) Emergency Reply: Double bloom slash and visual alarm at each control box.

(7) Mode 3/A Restriction: All common systems, select decode, identification, and emergency.

(f) Decoder Outputs.

(1) Number of Operator Positions: 11 maximum.

(2) Video Output.

(a) Polarity: Positive.

(b) Amplitude: 1 to 4V (adjustable).

(c) Pulse width: 0.7 us.

(3) Output Impedance: 75 ohms.